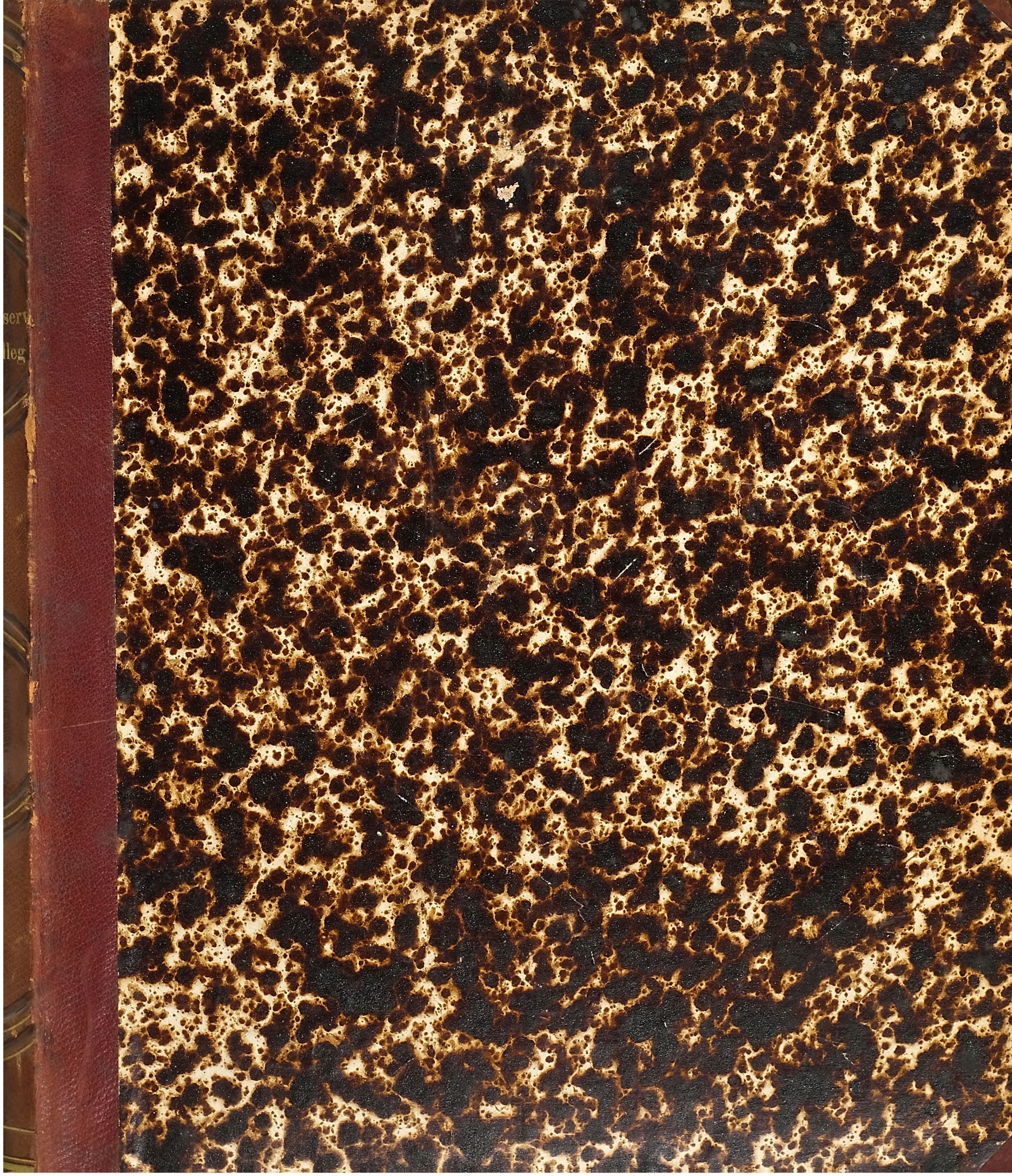




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Annals



ANNALS

OF

THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE.

VOL. XI.—PART I.

PHOTOMETRIC OBSERVATIONS

MADE PRINCIPALLY WITH THE EQUATORIAL TELESCOPE OF FIFTEEN INCHES APERTURE
DURING THE YEARS 1877-79,

BY

EDWARD C. PICKERING, DIRECTOR,

AIDED BY

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ASSISTANTS IN THE OBSERVATORY.

PRINTED FROM THE STURGIS FUND.

UNIVERSITY PRESS:
JOHN WILSON AND SON, CAMBRIDGE.
1879.



P R E F A C E.

IN the summer of 1877, it became necessary to select a subject to which the large Equatorial of the Harvard College Observatory should be devoted. Photometry was chosen, as offering a field in which the results promised to be of much value, and in which there seemed to be no danger of duplicating work in progress elsewhere, as large telescopes had been so little used previously for this purpose. The difficulties, however, proved serious in the outset. A new class of instruments had to be invented and constructed, and the lack of previous observations prevented the comparison of results, which generally forms so convenient a test of the quality of a scientific research. This was particularly the case with the satellites of Mars, which were discovered soon after this work was undertaken.

The greater portion of the measurements have been made with the East Equatorial, which has an aperture of 38 cms. (15 in.), and a focal length of 683 cms. (22 ft. 5 in.). Its work has been supplemented by a few measurements made with the West Equatorial, which has an aperture of 12.7 cms. (5 in.), and a focal length of 231 cms. (7 ft. 7 in.). Some measurements have also been made with other instruments, or by the naked eye.

The determination of the brightness of any object by means of its limit of visibility, or by the reduction in light required to make it barely visible, has been recommended by many astronomers for use in stellar photometry. In such observations, however, large errors may be caused by the presence of twilight or moonlight, by variations in the opacity of the air, in its steadiness, in the altitude of the object, or in the condition of the telescope. A still greater difficulty is the variation in sensitiveness of the eye as it becomes fatigued. For these reasons this method was not employed as a means of

measurement in the work described in the present volume. Its value, however, was tested by some experiments discussed on page 180, which show the magnitude of the variations to be expected in such measurements, when made by different persons on different days, even when relative determinations only are attempted.

Some preliminary experiments were made with a Zöllner's astrophotometer, and other instruments in which the star is compared with an artificial light. Good results may thus be obtained, but the errors caused by variations in the air apply also to this method. The great difficulty is the want of similarity in the two objects to be compared, especially when the star is bright. In this case, the real star presents a much smaller disk, is much brighter intrinsically, and is continually varying or twinkling. It is therefore very difficult to compare with a paler, larger, and steadier object. The lamp also varies, not only from night to night, but from minute to minute; and no correction can easily be applied for the changes in opacity of the air, which affect the star but not the artificial light. For these reasons the use of a lamp was abandoned in the following measurements, and the comparisons were made with some bright star in the vicinity of the object observed. All variations in the condition of the air were thus eliminated, both objects being affected equally by it. To insure a comparison free from personal equation, or variations due to the observer, it is very desirable that the objects shall resemble each other as much as possible. This result is secured by the methods described in Part I., in which the images compared are brought close together, and are so similar that it is difficult to distinguish one from the other. Both are seen with the same aperture of telescope, under the same magnifying power, and the light of both is equally distorted by passing through the same lenses and prisms. It is believed, therefore, that the results are unusually free from systematic error. A special study has, however, been made of the various errors to be apprehended, and precautions have been taken to eliminate them. The proximity of a bright star is shown to be a serious source of error in estimating the light of a faint star. The precautions here taken avoid errors from this source, which otherwise might amount to two or three magnitudes.

Most of the objects, the measurements of which are described in Part II., are too faint to be observed by the methods given in Part I. Many of them are regarded as severe tests of the quality of any but the very largest telescopes. That they might be seen distinctly, it was necessary that none of their light should be lost by the inter-

position of the prisms used to reduce the light of the object taken as a standard. It was therefore necessary to give up one of the conditions of accuracy attained in Part I., namely, that both objects should be seen under precisely the same conditions. This renders it more difficult to avoid the presence of systematic error. Moreover, all results will depend upon a constant to be determined for each instrument. The accordance of the values of this constant, as determined by four or five different methods, especially in the later observations, leads to the belief that the error from this source will be small.

The first observations were taken on Aug. 4, 1877, but no discussion has been made of the work of the first two or three weeks. Most of the measurements were made between Dec. 1, 1877, and Oct. 1, 1878. During these ten months, observations were obtained on nearly two hundred nights. Over fifteen thousand settings were made, arranged in thirty-four hundred sets. After October 1, certain observations were continued until March 18, 1879, although the observations originally planned had been completed. The entire series consists of over twenty-five thousand measurements arranged in five thousand sets. It was found that many of the observations could be made with undiminished accuracy, when the condition of the air was such that the observation of difficult objects was impossible. Care was therefore taken to select objects dependent on the character of the seeing, observing, for example, the faint stars when the moon was absent, and the close doubles when the air was steady. In this way, observations were obtained on almost every clear evening, or on about two out of every three nights.

The observations, with very few exceptions, have been made by Mr. Arthur Searle, Mr. Winslow Upton, and myself. Mr. Searle has also rendered important aid in the preparation and revision of the work.

The original observations were all recorded in pencil, and all reductions, explanations, or additional remarks made in ink. The means were computed and checked in the books containing the original record. A Journal, printed in Table I., was prepared, in which each evening's observations were entered with as little delay as possible. The proof of this Table was carefully compared by Mr. Searle and myself with the original record. Most of the ledgers were made from the manuscript Journal, but compared with the printed Journal. This afforded an additional check; and, should any discrepancies be found, it may be assumed that the Journal is

correct. Remarks are sometimes given in the text for which there was no room in Table I.

In the discussion, the average deviation of a single observation is commonly given instead of its probable error. The consideration of the latter can lead to a valuable result only when the observations are very numerous, and distributed according to the law of probabilities. In this case, the probable error may be deduced from the average deviation by a simple multiplication. The average deviation, on the other hand, forms a direct and convenient test of accordance, whatever may be the nature of the errors. In deference to custom, the probable error of the mean has been given. It should be remembered, however, especially in considering the results contained in Part II., that probable error is a test of accordance and not of correctness, when any undetected systematic errors may be present.

The probable errors are computed by the formula of Peters, from the first powers of the errors instead of from their squares. This method is easier, and is correct if the observations are numerous and well distributed. If these conditions are not fulfilled, neither formula should be used.

To represent the results, it is convenient to adopt some scale of magnitudes. The discussions which have been made of the estimates of various astronomers, show that they can generally be well represented by a logarithmic scale, in which equal divisions will correspond to equal ratios in the light. This seems to be the natural scale, or that demanded by the constitution of the eye. Some observers, as Seidel and Zöllner, represent the measurements directly by the logarithms of the light. This is open to the objection that the numbers obtained are not comparable with the stellar magnitudes in common use. Pogson has shown (*Monthly Notices*, xvi. 13) that a scale closely agreeing with that commonly employed in eye-estimates, may be obtained by the use of 0.4 as a divisor of the logarithmic ratios. This scale has been adopted throughout the present work. The computation is simple, and the true brightness is readily determined from it.

EDWARD C. PICKERING,

Director of the Observatory of Harvard College.

CAMBRIDGE, U.S., *August 1, 1879.*

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PHOTOMETRIC OBSERVATIONS.

PART I.

CHAPTER I.

DESCRIPTION OF INSTRUMENTS.

THE first instrument employed in the following photometric observations was constructed by attaching a Nicol to a double-image prism in such a way that it could turn freely around its axis. By a graduated circle and index, the angle could be measured to tenths of a degree. When two bright objects were viewed through this instrument, two images of each were formed by the double-image prism, either of which, by turning the Nicol, could be made as faint as was desirable. Whatever their relative light, the faint image of the brightest could thus always be reduced to equality with the bright image of the faint object. The true relative brightness is very simply deduced from the angle through which the Nicol is turned. Let A represent the brightness of one object, B that of the other, v_0 the reading of the index when one image disappears, and v its reading when the two images are equal. The brightness of the two images of the first object will then be denoted by $A \sin^2(v - v_0)$ and $A \cos^2(v - v_0)$. The corresponding expressions for the second object will be $B \sin^2(v - v_0)$ and $B \cos^2(v - v_0)$. But, if the second and third of the four images are equal, we must have $A \cos^2(v - v_0) = B \sin^2(v - v_0)$ or $\frac{A}{B} = \tan^2(v - v_0)$. In the comparisons, it is often more convenient to use logarithms, in which case we have $\log A - \log B = 2 \log \tan(v - v_0)$. Evidently for any value of $\frac{A}{B}$ we shall find four values of v satisfying this equation, v , $2v_0 - v$, $180^\circ + v$, $180^\circ + 2v_0 - v$, or there are four positions of the Nicol in which the two images will be equal. Although either one of these may be used, it is better to observe all four. Half the difference of the first and second, or of the third and fourth, will give the required quantity $v - v_0$, so that v_0 need not be observed directly. The mean of these two values will eliminate the error due to an obliquity in the axis of the Nicol.

This form of photometer may be used without a telescope in the comparison of bright stars which are sufficiently near each other, but the loss of light is large. By

Fresnel's formula for the reflection of light, each of the four surfaces of the prisms will reflect four per cent. The amount they would transmit, were there no other losses, would therefore be $(.96)^4 = .849$. This supposes that the faces of the Nicol are perpendicular to its axis. If made of the usual form, the loss would be still greater. The unavoidable defects of the surface, dust, absorption, and the reflection at the surface of the balsam cementing the prism, reduce still further the transmitted light. About .80 will remain under favorable circumstances. Since the prism forms two equal images, only one half or .40 can pass into each. If the Nicol is set at v_0 , two of the images will have this brightness; but, unless the disparity in brightness of the objects to be compared is so great that it can be kept close to this point, a still further reduction is made. In the most unfavorable case, when the two objects are equal, this reduction amounts to one half. Accordingly, when the two images are reduced to equality, their brightness will be only .20 to .40 of that of the fainter object. For any but the brightest of the heavenly bodies, it is accordingly necessary to increase the light by means of a telescope. Since the relative positions of the Nicol and double-image prism are unimportant, either might be placed in front of the object-glass, between the object-glass and the field-lens, between the field-lens and eye-lens, or between the eye-lens and the eye. Unless the double-image prism is placed in front of the object-glass, two images of the latter will, in general, be formed, giving two emergent pencils, both of which must pass without loss into the eye. There is danger that on moving the eye one or other of these pencils will be partially cut off, thus reducing the brightness of one of the objects. If the two images to be compared are brought very near together, this is less likely to occur. On the other hand, at least one of the images of a double-image prism is not achromatic; and, if the prism is placed in front of the object-glass, the color becomes very marked. In this case, also, it becomes difficult to obtain a prism having such flat surfaces that the images will not be distorted, since any irregularities are magnified by the full power of the telescope. If the two images are separated by a distance d , any two stars at about this interval may be brought together, so that any star may be compared with all those on the circumference of a circle having a radius d . With a large prism in which d equalled about 3° , an attempt was made to compare β and ρ *Persei* and β and γ *Lyræ* by placing the prism in front of the objective of a telescope having an aperture of about 10 cms. A direct measure of the variations in brightness of the above-named variable stars might thus be obtained. This plan was abandoned, owing to the color of the images.

There is one other position of the prism, that where the eye-piece forms its image of the objective, in which the emergent pencil will remain undivided. This is, however, the exact point at which the eye should be placed; and, moreover, the interval between the images cannot, in this case, be altered. Good results were obtained by

placing the prism a little nearer the eye-piece, as in the first of the instruments described below. The advantage of placing the prism between the eye-lens and field-lens is that it is less likely to reduce the field of view. As this plan is open to the double objection of dividing the emergent pencil and keeping the images always at the same distance apart, it has not been employed in the following observations.

The fourth position for the prism is between the field-lens and objective. It then separates the emergent pencils by an amount increasing with its distance from the objective, but, on the other hand, the interval between the images is proportional to its distance from the focus. Whatever, therefore, is the interval between the two stars, within certain limits, their images may always be made to coincide by first turning the prism and then sliding it along the axis of the telescope to the proper distance from the focus. A prism may therefore be used, in which the separation is small, and thus the two images of the objective may be rendered nearly coincident.

The position of the Nicol is comparatively unimportant. Since it must turn without moving the double-image prism, it is more convenient to place it between the latter and the eye. It was, accordingly, sometimes placed between the eye-lens and the eye, and sometimes between the field-lens and eye-lens.

The first of the following observations were made with an eye-piece having a Nicol between its two lenses and with the double-image prism between the eye-lens and the eye. The focal length of the eye-piece was 5.4 cms.; and, as it was attached to the West Equatorial, the magnifying power was 43 diameters. The observations made with this apparatus are to be regarded as preliminary, although the errors are probably accidental rather than constant. This photometer — which will hereafter be called Photometer A — was used from Aug. 4, 1877, to Aug. 16, 1877, on the components of wide double stars and on the satellites of Jupiter.

Meanwhile, a second photometer had been constructed, in which the Nicol and double-image prism were both placed in front of the eye-lens, the Nicol being next the eye. One marked advantage of this instrument, which will be designated as Photometer B, was that the circle, instead of the index, turned with the Nicol. The labor of reading was thus much reduced. At one time, the Nicol was replaced by a double-image prism, with the advantage that the field of view was less obstructed. The great number of images formed by successive reflections, when a bright object was observed, rendered it sometimes difficult to determine which should be compared. Later, a much simpler arrangement, known as Photometer C, was used. It consisted of two concentric tubes, one carrying a graduated circle, the other two indices. In the first of these tubes, a double-image prism was inserted; the other, which was held next the eye, carried a Nicol. This photometer was used without a telescope to compare the relative brightness of Saturn and Mars, and Jupiter and Venus. After

Nov. 7, 1877, a tube was attached to this photometer, so that the light should always pass nearly normally through the prisms. When the objects were sufficiently bright, and within a few degrees of one another, good results were thus obtained, but the color of the images, and their want of symmetry, was a serious objection when a great difference in light was to be measured.

After an experience of some months with these instruments, certain improvements suggested themselves, and Photometer H was constructed. It is represented in per-

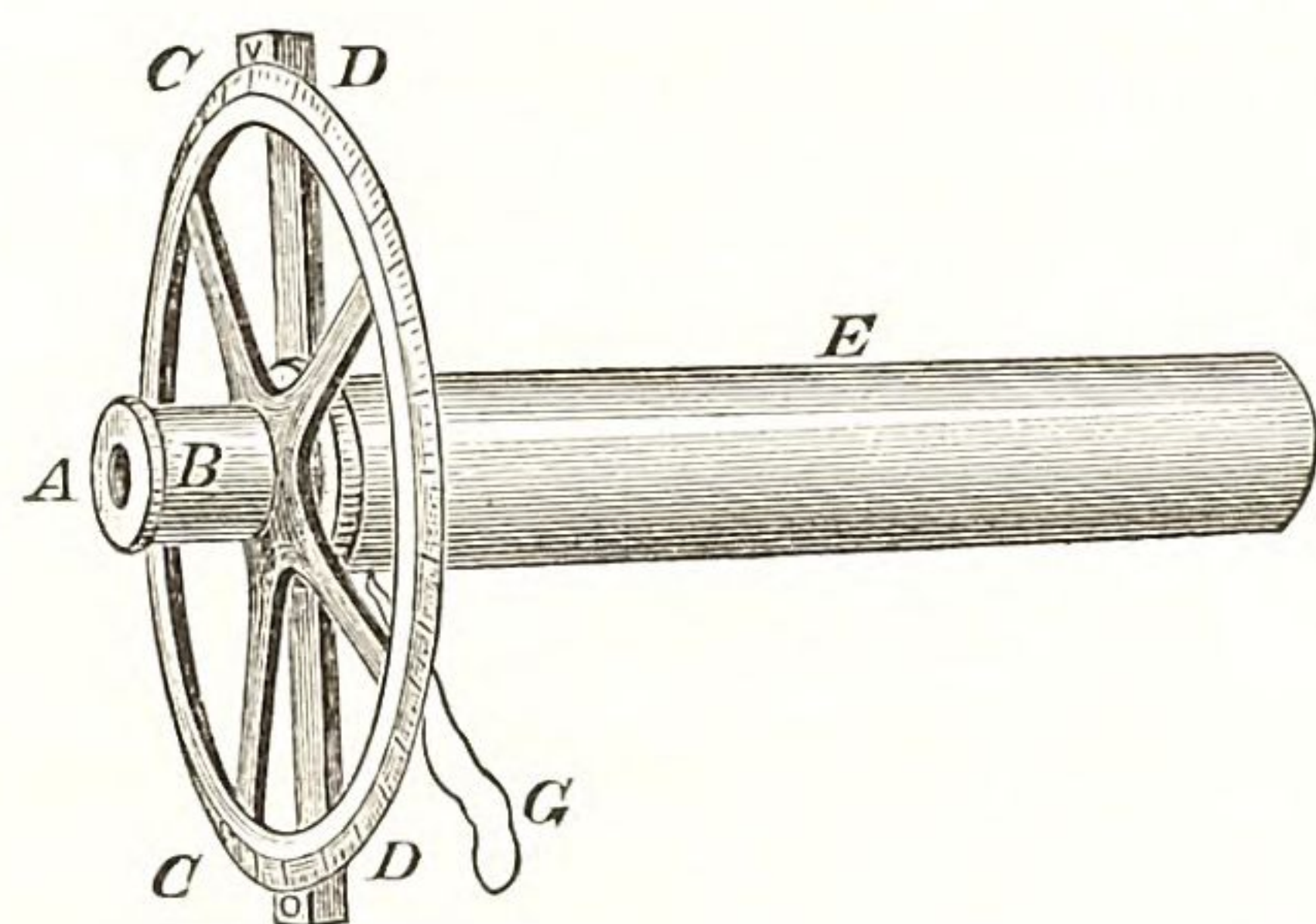


Fig. 1.

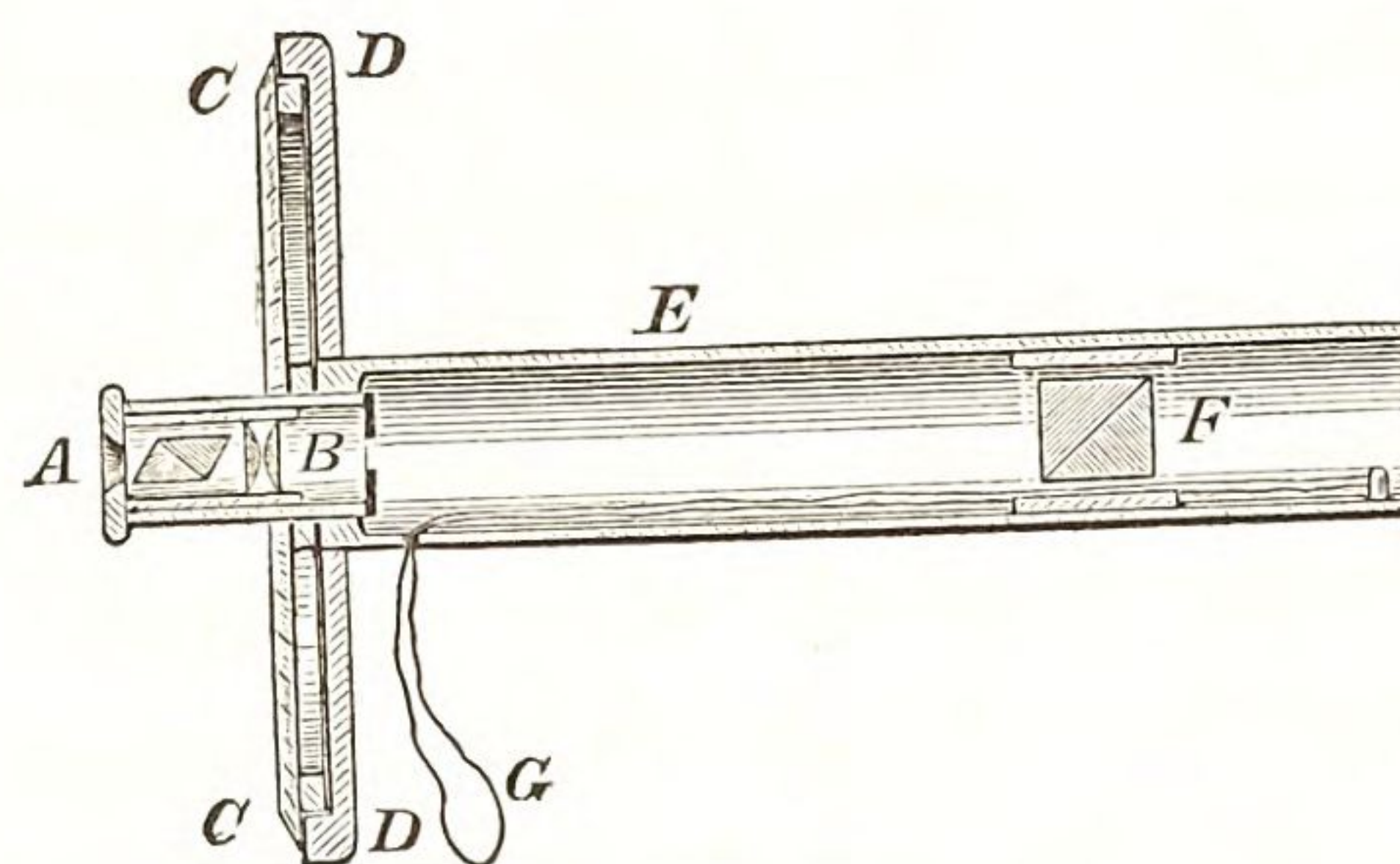


Fig. 2.

spective in Fig. 1, and in section, on a scale of one fifth, in Fig. 2. Photometer C was attached to a tube, which will slide into the end of either the East or West Equatorial. In both figures, *B* represents the eye-piece, in front of which is inserted a Nicol, *A*. A circle, divided into degrees, is attached, and turns with the eye-piece. The indices *D D* are fastened to the tube *E*, which slides into the telescopes. *F* is a Rochon prism, which was used instead of a double-image prism of spar. As it consisted of quartz, the separation of the images amounted to somewhat less than 1° , so that the emergent pencils overlapped each other by nearly three quarters of the diameter of each. The apparatus had, moreover, the great advantage that the images were precisely alike and nearly achromatic. The prism was placed in a tube, which could be drawn towards or from the eye-piece by a cord, *G*. Attaching this photometer to a telescope, and directing it towards a star, the latter appeared double; and the interval between the components might be altered, at will, from zero to .212 cms. This corresponds to the angular intervals of $64''$ and $190''$, with the telescopes named above. The field was limited by a diaphragm which subtended to the eye an angle of about 9° ; and the light, therefore, always passed nearly normally through the prisms. The angular diameters of the field in the two telescopes were $133''$ and $396''$, and the magnifying powers were respectively 250 and 84.

These photometers could only be used for comparing objects very near together, as double stars, or satellites. For greater intervals, another device was tried. Two achromatic prisms of small angle were placed in front of a telescope, so as to cover the central portion of its object-glass. Two images of any object would thus be

formed, separated by an interval dependent on the angle of the prisms and on their relative positions. By turning one or both of the prisms, the directions of the two images may be altered at will, and their distance varied between the sum and the difference of the angular deviation of the prisms. After bringing the images near together, they could be compared by one of the photometers described above. This method was tried with two circular prisms, having a diameter of 4.4 cms., and producing a deviation of about $1^{\circ}.3$. A telescope was used having an aperture of 10 cms. The light of any objects nearer than $2^{\circ}.6$ could be measured with this instrument. The constant, or proportion of the light transmitted by the prisms, was easily determined by comparing, by the photometer, the two images of the same object. This instrument, like those previously described, has the great advantage that both objects are seen under the same magnifying power, and therefore closely resemble each other, even when the condition of the air is not good. This plan cannot be used for large intervals, since, if the angles of the prisms are large, the images will be colored by the secondary spectrum, and it would also be difficult to find the objects. With a large telescope, the prisms could not be reached easily by the observer, and the large diameter required would be an objection to their use.

The idea early suggested itself that the photometers described above might be used to compare the colors of the components of double stars, by measuring the relative light of different portions of their spectra. This plan was not carried out until the summer of 1878, when a combined spectroscope and photometer, called Photometer O, was devised. This instrument is shown, in

section, in Fig. 3, on a scale of one-fifth. As in Photometer H, *A* is a Nicol, placed in front of the eye-piece, *B*. The graduated circle *C C* is attached directly to the tube carrying the Nicol; and the indices *D D* are fastened to the tube *G*, which slides into the telescope. *H* is a direct-vision prism, by which the images of the stars are converted

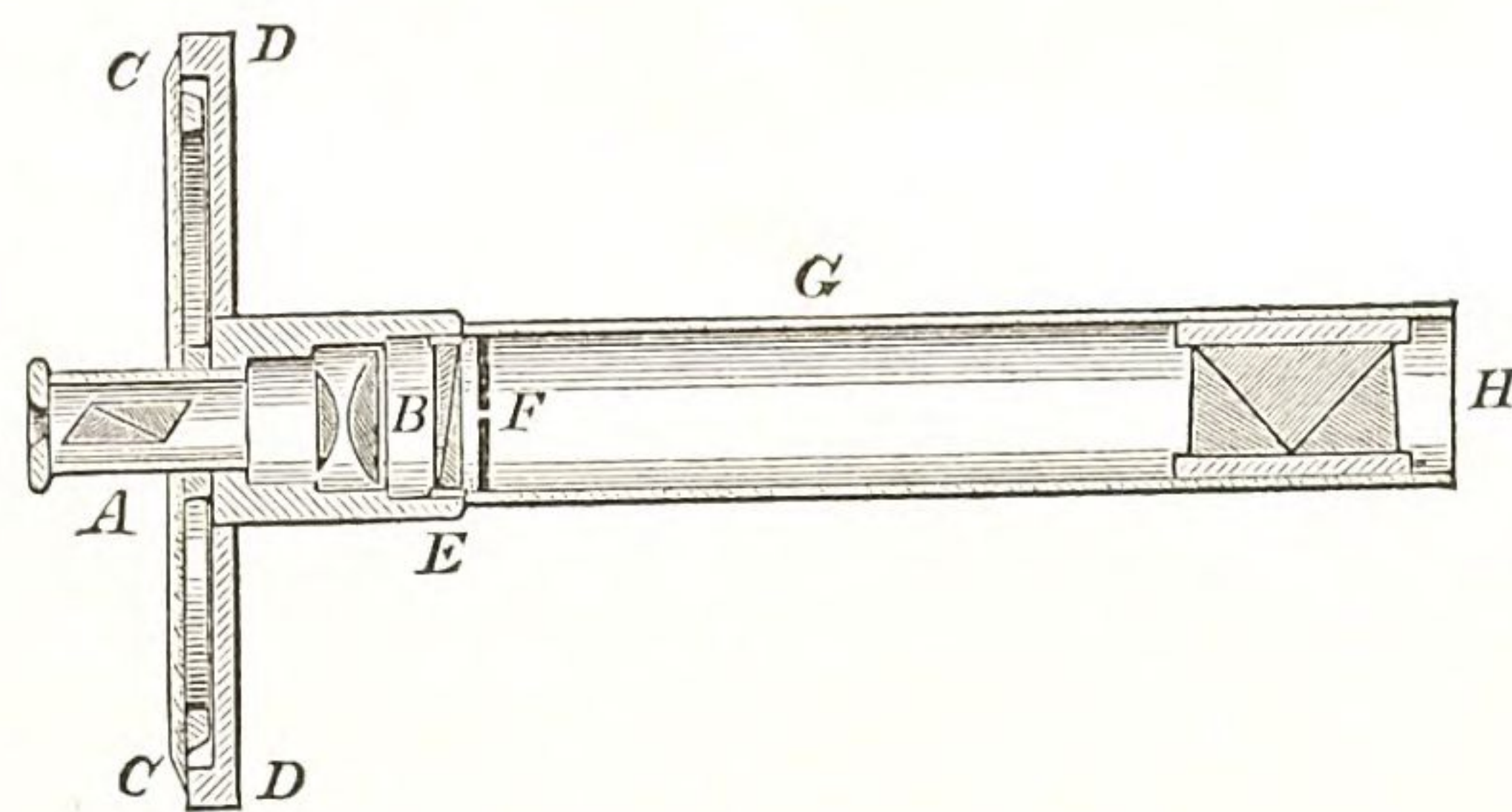


Fig. 3.

into linear spectra, or lines of light, red at one end, and blue at the other. *F* is a diaphragm, placed at the focus, and having a slit in it .02 cms. broad, parallel to the edges of the prism, *H*. It is, therefore, perpendicular to the spectra, and permits a short portion of each to pass through. These appear as two stars, of a color which may be varied with the position of the objects observed, as regards the axis of the telescope. Their relative light was measured by forming two images of each, by a plate of Iceland spar, *E*, which was used instead of a double-image prism, since the rays were not parallel. The light was then measured by turning the Nicol *A*.

All of the photometers described above are open to the objection that the loss of light is very great. As already stated, under the most favorable circumstances only .20 to .40 of the light is used; so that, with the large telescope of aperture 38 cms., faint objects appear no brighter than with a telescope having an aperture of 18 to 24 cms., with a common eye-piece. This trouble was greatly felt during the observations of the satellites of Mars, and led to the invention of a class of photometers of wholly different form.

The image of some bright object, assumed as a standard, is reflected into the field of the telescope, and its light reduced by a known amount, until it is no brighter than the object to be measured. An unobstructed view of the latter is obtained,

meanwhile, with an eye-piece of the usual form. The first of these instruments, denoted as Photometer D, is represented in section, in Fig. 4, on a scale of one fifth.

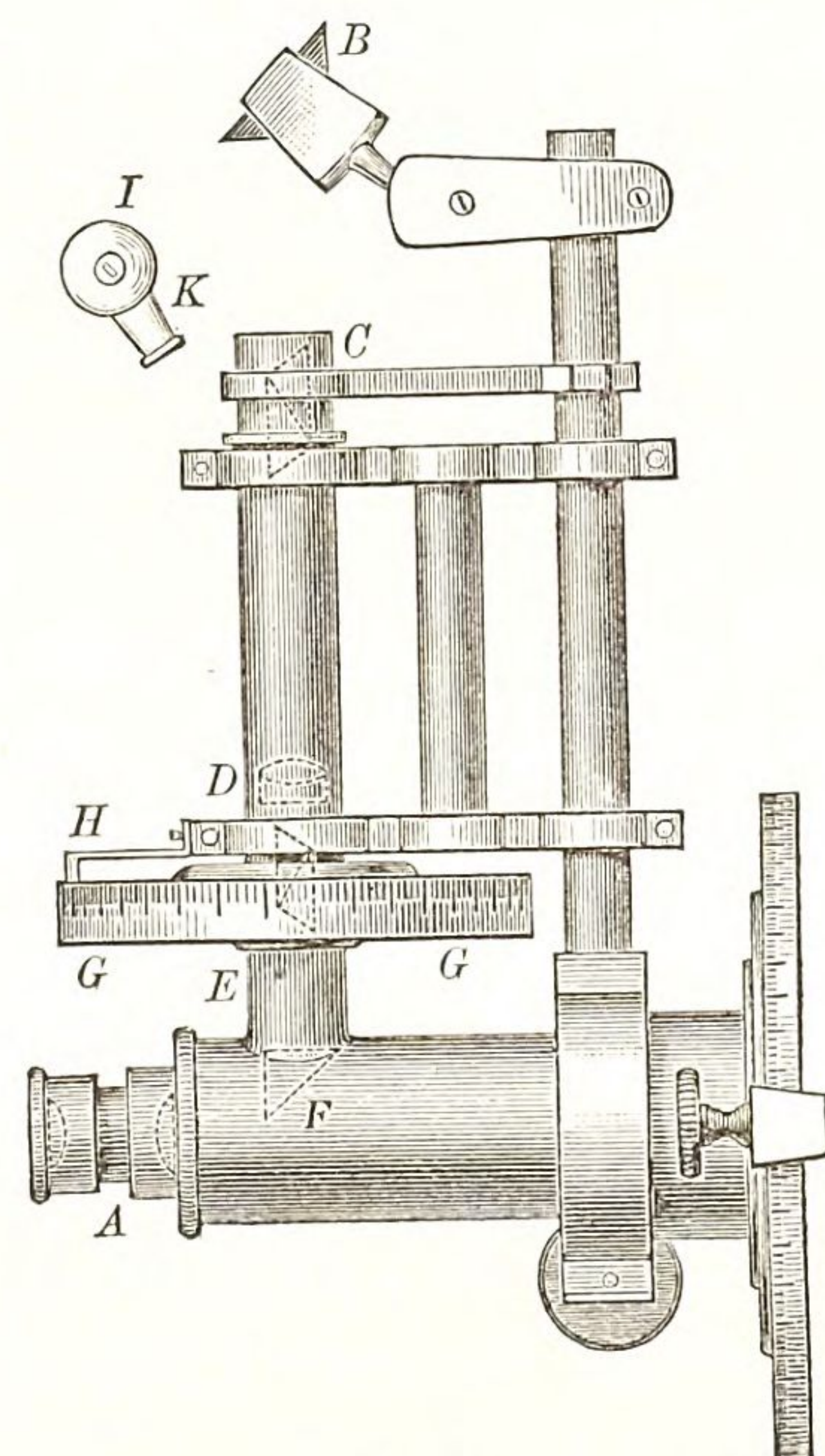


Fig. 4.

The image of the faint object formed by the telescope is viewed by the eye-piece *A*. The light of the bright star, taken as a standard, passes outside of the telescope, and falls upon the prism *B*. By this, it is reflected through the objective *D* of a small auxiliary telescope, and, falling on the prism *F*, is brought into the field of view. The faint object is thus seen in one half of the field with the full aperture of the telescope; while the bright standard appears in the other half of the field, its image being formed by the small telescope. *C* and *E* are two Nicols, of which *E* may be rotated, and the light passing through it reduced at will. *G G* is a graduated circle, attached to the tube carrying *D* and *E*, and measuring the reduction of the light by an index *H*, which is fixed. The whole photometer may be turned around the axis of the large telescope, the tube carrying the prism enables the latter to rotate around the axis of the auxiliary telescope, and, finally, the prism may be tipped around an axis parallel to its edges. Either two of these motions enable the observer to bring any object into the field of view of the small telescope. Practically, the second and third motions were used for the purpose. The first of these movements was reserved almost exclusively for the purpose of placing the prism so that it would conceal the bright star or planet with which the faint object was to be compared, when their distance apart was small. Otherwise, its light as seen in the large telescope, would be so intense as to interfere with the proper estimate of the light of

the faint object. *I* is a lamp, by which the half of the field covered by the prism *F* may be illuminated, so as to render it as bright as the other half of the field. A piece of blue glass, *K*, served to vary the color of the light.

Great difficulty was experienced in obtaining good images of bright stars with the small telescope, on account of the Nicols used. Since the rays passing through *E* are convergent, aberration is caused by the obliquity of its faces, even if they are plane and parallel. After using Photometer D for about a month, the Nicols were removed, and the light varied in a different way. The lenses of a double-image micrometer were taken out, and two V-shaped pieces of brass were attached to the slides carrying the divided lens. A square hole, or "cat's eye," was thus formed, whose dimensions could be altered at will, by turning the micrometer screw. This arrangement is shown in *M N*, Fig. 6. Placing it near the objective *D*, Fig. 4, the light was varied by changing the aperture of the small telescope. It was inserted between *D* and *F*, for convenience; although a position between *B* and *D*, where the light is parallel, possesses theoretical advantages. The instrument, in this form, is called Photometer E. Good results were obtained with it; but, when a faint comparison star was employed, the aperture varied so slowly, owing to the fine pitch of the screw, that the eye became fatigued before the images could be rendered equal. A screw of larger pitch was accordingly substituted, which moved one plate instead of both. The construction was thus simplified, although the aperture did not remain concentric with the objective *D*, when the screw was turned. This instrument, called Photometer G, in common with D and E, is open to the criticism that it was heavy, difficult

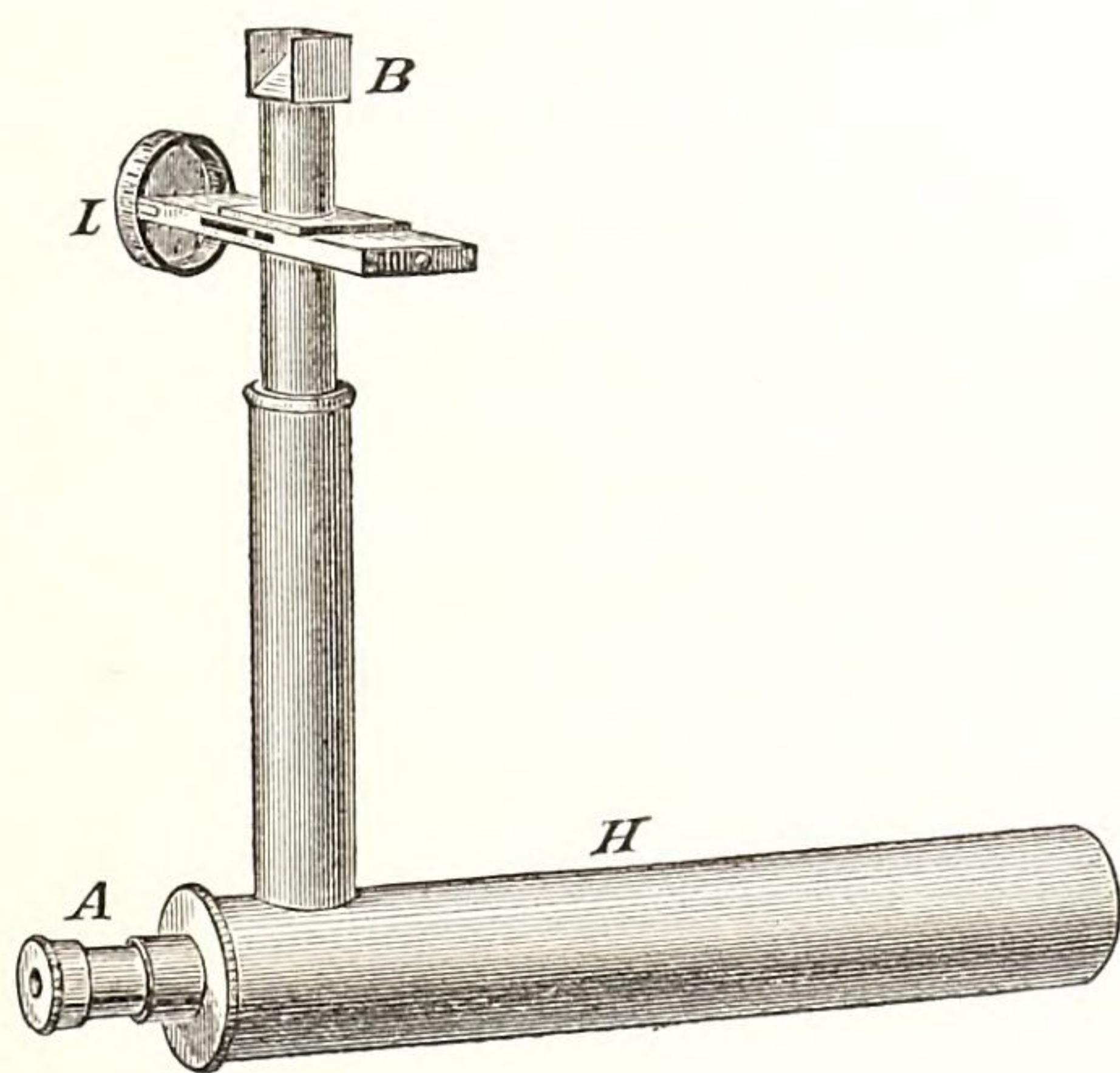


Fig. 5.

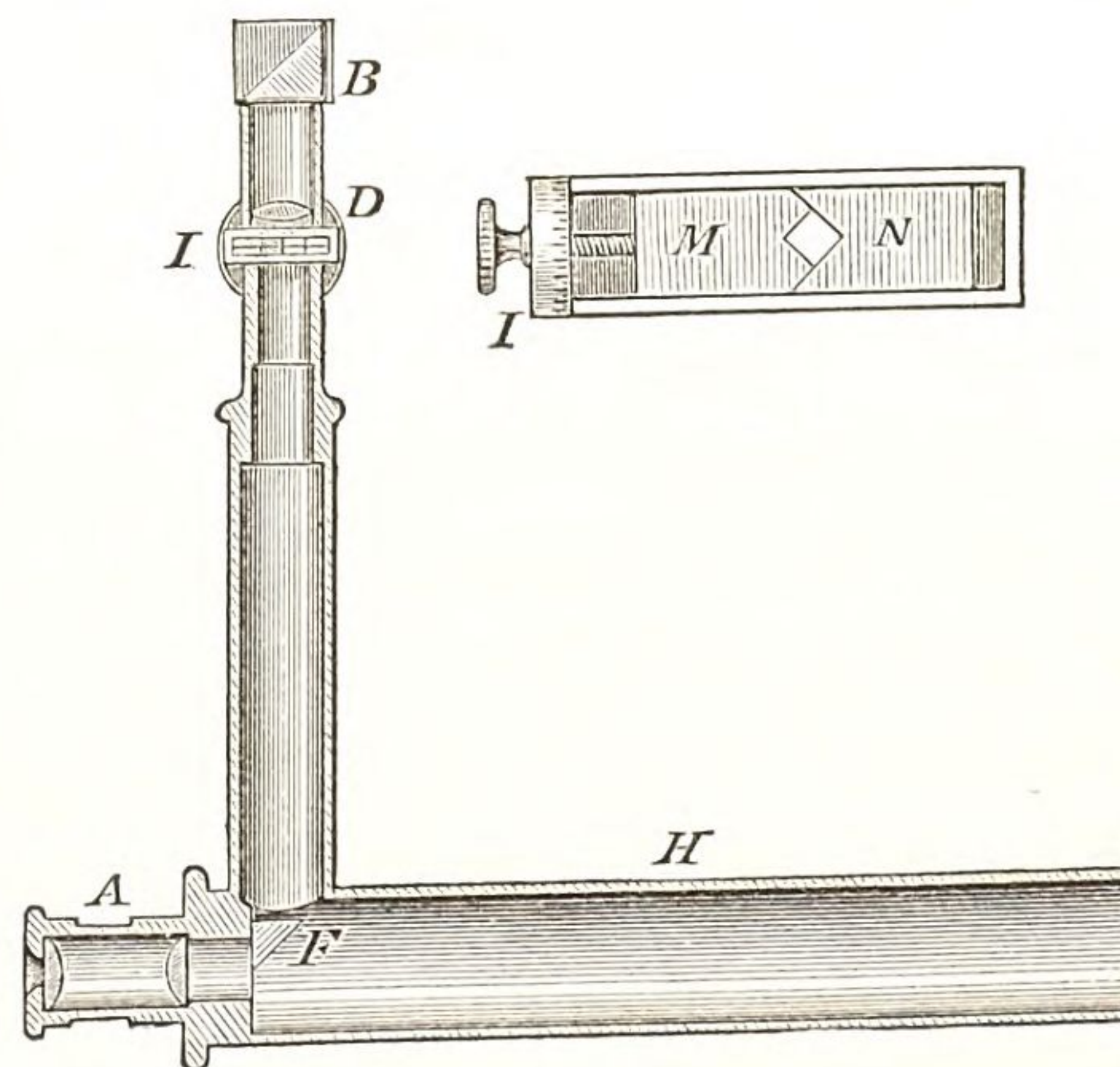


Fig. 6.

to adjust, and not easily removed and replaced. These defects were remedied in Photometer I, which is represented in perspective in Fig. 5, and in section, on a scale of one fifth, in Fig. 6. The same letters are used as in Fig. 4 for the corresponding

parts of Photometer D. The faint object is viewed with the eye-piece *A*, while the light of the bright object, passing down the side of the telescope, is reflected by the prism *B* into the object-glass *D*, whose aperture is varied by the screw *I*, which moves the plates *M N*, as in Photometers E and G. Finally, the prism *F* throws the light into the field of *A*. The whole is attached to the tube *H*, which slides into the end of the telescope. This photometer is light, can be easily removed, and by a suitable adapter may be attached to any telescope. As it forms a single piece, the adjustments are less liable to be disturbed than those of Photometers D, E, or G.

In some observations, especially during twilight or moonlight, errors were apprehended from the comparative darkness of that half of the field covered by the prism *F*. Photometers E and I were accordingly modified by replacing this prism by a piece of parallel glass. They were then called Photometers E' and J. The reflected stars they formed were much fainter, and double; one image being produced by each surface of the glass. These instruments had the advantage that the field was unobstructed, and the star to be measured might be placed in any desired position, as regards the standard.

This class of photometers can be used only in the measurement of faint stars. If the image of the object seen in the large telescope is brighter than that formed by the auxiliary telescope, no setting of the Nicols or micrometer screw will render them equal. This difficulty was obviated in Photometer F, which was formed by removing the Nicols of Photometer D and replacing its eye-piece by Photometer C. The images of the same object, seen in the large and small telescope, were first compared, and the constant thus found was used in reducing the observations of other objects. The advantages of this photometer are that stars of greatly different brightness and in different parts of the sky may be compared; but the loss of light is great, and the images are seen under different magnifying powers.

The reduction of observations made with Photometers D, E, E', G, I, and J, likewise depends upon the relative amounts of light transmitted by the large and small telescopes. The questions connected with this subject are discussed in Part II., Chapters V. and VI.

CHAPTER II.

JOURNAL.

TABLE I. exhibits the results derived from the successive sets of photometric observations discussed in the present volume, except in those cases where their nature did not permit the results to be entered in a simple form. Only the number of the observations in the set then appears in the Journal.

The sets are numbered consecutively in the first column of the Table. The second column contains the dates ; and the third, the hours of the observations, expressed in Cambridge mean time. When the time of a set of observations was not so definitely recorded that it could be stated correctly to the tenth of an hour, the decimal point is omitted. The tenth has occasionally been supplied by interpolation, where there seemed to be no risk of error in the process.

The fourth column contains the names of the objects observed. To save space in this column, a system of nomenclature has been adopted, which will be explained below. The fifth column states the number of separate observations of which each set is composed. The sixth column contains the mean result directly obtained from each set, in terms varying with the instruments used in the observations ; and the seventh column, the zero of the instrument, when its effect was eliminated by the observations, so that it could be regarded as redetermined in each set.

The last three columns contain the initials of the observers, the letters designating the photometers employed, and such remarks as were short enough for insertion ; others appear in the subsequent discussion of the observations ; and some account of the abbreviations employed will be given in this chapter. The observers were chiefly E. C. Pickering (P.), Arthur Searle (S.), and Winslow Upton (U.). The initials of other observers are explained in the column of Remarks. Brackets, [], enclosing the letter designating the photometer, signify that the instrument was not attached to a telescope, but held in the hand, or mounted on a stand with a small object-glass, in order to determine its constant ; parentheses, (), show that it was attached to the West Equatorial. In other cases, the photometers were used with the East Equatorial.

In the column of names, the comma is employed between the designations of any two objects photometrically compared with each other. Some differences of nomen-

clature depend on instrumental differences. Photometers A, B, C, H, and O, were chiefly used for comparing objects of no very great difference in brightness. The nomenclature required by their use in other cases will be explained in the next paragraph. When a double star is observed with one of these photometers, the column of names contains only the name of the star; if the star is multiple, its name is followed by the letters denoting the two components measured. Two components observed as a single object are denoted by two letters not separated by a comma. In an observation of a multiple star, if the component called B (for example) appears, by the observation, to be fainter than that called C, the column headed "Reading" will contain a number greater than 45. This also occurs in observations of double stars, when the accepted order of brightness appears to be reversed by the observation. In comparisons between other objects, that which is assumed to be the brighter is named last; and a reversal of this order by the observation is indicated as just explained. The assumed order for Jupiter's satellites is as follows: IV, II, I, III. Jupiter II, I, accordingly, denotes a comparison between the second and first satellites of Jupiter. But in comparisons between two of the satellites, at the beginning or end of an eclipse of either, the other was regarded as the standard of comparison and therefore named last.

Photometers D, E, E', F, G, I, J, are instruments designed for the comparison of very faint objects with others of considerable brightness. If one component of a multiple star, or the satellite of a planet, is entered as observed, the chief component of the star, or the planet itself, is understood to be the standard of comparison. When a different standard is used, its name follows that of the faint object. The small holes in tin-foil, brass, or platinum, through which portions of planetary disks were sometimes observed, are designated by letters and numbers, which are placed last in the column of names. From the preceding remarks, it will appear that such expressions as Jupiter II, A 1 — Deimos, B 1 — Mars, R 3 — Neptune, Moon N 1 — respectively denote comparisons between the second satellite of Jupiter and part of Jupiter itself, seen through the hole called A 1; between Deimos and part of Mars, seen through B 1; between the whole disk of Mars and the part of it seen through R 3; and between the whole disk of Neptune and the part of the Moon seen through N 1. The whole disk of a bright planet, in comparisons of this kind, is reduced to a small stellar object by the auxiliary telescope of the photometer. In observations made to determine the constant of a photometer, a single object — the sky, for instance, or an artificial star — is usually observed in two different ways. In some cases, the column of Remarks contains notes explanatory of the column of names.

Some of the photometers had two opposite indices, either of which might be used

in reading the graduated circle. The index read was occasionally recorded as Index O or Index V; and these designations have been retained in the column of Remarks. Estimated angles recorded in the same column, when not evidently position angles, are to be understood as relating to the position of the observer; 0° denoting a direction towards the lower part of the field, 90° towards the right, and so on. "Index V 225° " will therefore mean that Index V of the photometer was to the left and above, and that the observations were made by means of this index. In the later observations with Photometer H, it was the practice to record the estimated position (on the system just explained) and distance of the two images compared, the image formed by the object assumed to be actually the brighter being taken as the centre. The figures thus obtained have been entered in the column of Remarks, where, accordingly, " $90^\circ, 5''$ " means that the fainter object was to the right of the other, and distant from it about $5''$.

The character of the images, as regards distinctness, steadiness, and size, was estimated, especially in the later observations, on a scale of nine; 8 denoting good, 5 medium, 2 bad, and so on. Thus 7, 5, 3, signifies that the atmosphere was clear, and the images moderately steady, but rather large. These figures are sometimes used to save space in the column of Remarks, instead of the notes found in the original record, before the practice of employing the figures had become established.

The images compared by Photometer H were said to be "reversed," when, by turning the position circle, they were made approximately to exchange places. The record of this change was usually omitted after it became a customary practice.

Readings called "increasing" and "decreasing" are made by setting the photometer, before making the comparison, at too small a reading in the first case, and at too large a reading in the second. The final setting for a reading called "increasing" might or might not be made by increasing the reading.

Observations were rejected only for defects perceived at the time, and not for mere discordance.

TABLE I.



JOURNAL

CONTAINING

THE PHOTOMETRIC OBSERVATIONS MADE FROM AUGUST, 1877, TO SEPTEMBER, 1878,
WITH A PORTION OF THOSE MADE FROM OCTOBER, 1878, TO MARCH, 1879.

PHOTOMETRIC OBSERVATIONS.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1	Aug. 4	7	Jupiter IV, III . .	8	28.56	154.71	P.	(A.)	Too near sunset.
2	" "	7	" I, III . .	6	30.42	153.75	P.	(A.)	Dome partially covers object-glass.
3	" "	8	" I, III . .	8	23.32	243.35	P.	(A.)	
4	" "	8	" II, III . .	8	33.21	240.81	P.	(A.)	
5	Aug. 6	8	" II, III . .	4	33.35	152.30	P.	(A.)	
6	" "	8	" II, III . .	4	33.80	157.20	P.	(A.)	
7	" "	8	α Ursæ Majoris . .	4	4.57	245.92	P.	(A.)	
8	" "	8.2	" " . .	10	4.37	335.99	P.	(A.)	Clouds.
9	" "	8.3	" " . .	6	5.71	154.49	P.	(A.)	
10	" "	8.6	β Scorpii . .	4	16.45	153.25	P.	(A.)	
11	" "	9	" " . .	5	16.67	152.62	P.	(A.)	
12	" "	9	ν Scorpii . .	5	15.10	154.80	P.	(A.)	Images 40" apart.
13	" "	9	" " . .	6	15.40	66.27	P.	(A.)	[Clouds.]
14	" "	9.5	β Capricorni . .	4	15.00	241.40	P.	(A.)	
15	" "	10	" " . .	10	14.87	152.07	P.	(A.)	
16	" "	10	" " . .	2	13.40	335.50	P.	(A.)	
17	Aug. 7	8.0	ζ Ursæ Majoris . .	6	19.60	154.50	P.	(A.)	
18	" "	8.6	" " . .	4	17.20	335.50	P.	(A.)	Hazy.
19	Aug. 8	8.1	Jupiter I, III . .	8	40.80	152.71	P.	(A.)	Troubled by clouds.
20	" "	8	" II, I . .	8	46.20	154.61	P.	(A.)	
21	" "	8	β Scorpii . .	10	14.38	335.17	P.	(A.)	
22	" "	8	" " . .	10	13.47	155.33	P.	(A.)	
23	" "	8	α Capricorni . .	8	39.12	153.62	P.	(A.)	
24	" "	8	β Capricorni . .	10	17.71	161.01	P.	(A.)	
25	" "	8	" " . .	10	16.93	153.19	P.	(A.)	
26	" "	9.5	ζ Ursæ Majoris . .	10	18.24	64.04	P.	(A.)	} Alternate readings.
27	" "	9.5	" " . .	10	19.99	244.65	P.	(A.)	
28	" "	9.8	α Ursæ Majoris . .	10	6.06	245.42	P.	(A.)	} Alternate readings.
29	" "	9.8	" " . .	10	7.31	65.25	P.	(A.)	
30	Aug. 10	8.1	β Cygni . .	10	16.11	154.83	P.	(A.)	Clouds. Colors marked.
31	Aug. 11	7.9	Jupiter I, III . .	8	35.24	243.48	P.	(A.)	
32	" "	8.0	" IV, III . .	8	27.82	245.27	P.	(A.)	
33	" "	8.1	ϑ Serpentis . .	8	38.82	156.71	P.	(A.)	
34	" "	8.3	α Ursæ Majoris . .	10	6.37	64.82	P.	(A.)	
35	" "	8.5	ν Scorpii . .	10	17.07	155.61	P.	(A.)	
36	" "	10.4	Jupiter IV, III . .	8	23.90	155.21	P.	(A.)	
37	" "	10.8	α Aquilæ . .	10	1.51	244.77	P.	A.	
38	" "	11	β Capricorni . .	10	17.61	245.61	P.	(A.)	
39	" "	11	" " . .	10	19.25	63.85	U.	(A.)	
40	" "	11	α Capricorni . .	12	37.35	151.71	P.	(A.)	
41	" "	11.4	" " . .	12	41.75	155.08	U.	(A.)	
42	" "	11.7	α Ursæ Majoris . .	10	7.53	245.49	P.	(A.)	
43	" "	11.8	" " . .	10	12.14	69.55	U.	(A.)	
44	" "	12.0	ζ Lyræ . .	11	21.71	64.89	P.	(A.)	
45	" "	12.3	ϵ , δ Lyræ . .	8	42.49	152.21	P.	(A.)	
46	Aug. 12	7.7	Jupiter IV, II . .	11	32.04	63.16	P.	(A.)	Clouds.
47	" "	8.0	β Scorpii . .	11	13.04	154.04	P.	(A.)	Clear again.
48	" "	8.8	α Ursæ Majoris . .	10	7.81	155.35	P.	(A.)	
49	" "	9.5	β Capricorni . .	10	16.64	154.06	P.	(A.)	
50	" "	9.6	α Ursæ Majoris . .	7	7.13	333.31	P.	(A.)	
51	" "	9.9	" " . .	11	7.86	334.32	R.	(A.)	Observer, W. A. Rogers.
52	Aug. 16	8	β Capricorni . .	10	22.08	300.04	P.	(B.)	
53	" "	8.5	α Ursæ Majoris . .	10	8.39	205.35	P.	(B.)	
54	" "	11	α Aquilæ . .	10	1.90	31.28	P.	B.	
55	" "	11	" " . .	10	1.98	210.04	P.	B.	
56	" "	11	" " . .	10	1.63	30.95	H.	B.	} Observer, E. S. Holden.
57	" "	11	" " . .	10	1.62	209.72	H.	B.	
58	" "	11	" " . .	10	1.91	209.45	P.	B.	
59	" "	11	" " . .	8	2.01	209.38	S.	B.	
60	" "	11	" " . .	10	2.15	209.19	S.	B.	
Total Number . .				511					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
61	Aug. 16	11	α Aquilæ . . .	10	2.05	30.13	S.	B.	
62	Aug. 17	8.0	Jupiter IV, III . .	8	33.61	210.41	P.	(B.)	
63	" "	8	β Capricorni . .	10	18.23	211.33	P.	(B.)	
64	" "	9	α Aquilæ . . .	10	1.66	30.88	P.	B.	
65	" "	9	" . . .	10	2.13	209.07	S.	B.	
66	" "	9	ζ Ursæ Majoris .	8	17.65	121.19	P.	B.	
67	" "	9	" " . . .	10	19.38	211.52	P.	B.	
68	" "	10.6	α Aquilæ . . .	10	2.32	29.32	P.	B.	
69	" "	11	" . . .	10	2.45	29.43	S.	B.	
70	" "	11	" . . .	10	2.95	29.13	U.	B.	
71	Aug. 18	10	Jupiter II, III . .	8	39.69	177.56	P.	(B.)	Poor.
72	" "	11	β Capricorni . .	10	11.66	268.82	P.	(B.)	
73	" "	11	" . . .	10	16.07	224.31	P.	(A.)	
74	" "	12.0	Saturn, Mars . .	10	13.04	179.56	P.	[B.]	
75	" "	12.2	" " . . .	10	12.65	359.73	P.	[B.]	
76	" "	12.3	" " . . .	10	13.13	181.96	U.	[B.]	
77	" "	12.5	" " . . .	10	13.04	179.78	P.	[B.]	
78	Aug. 19	8	β Scorpii . . .	10	19.35	232.05	P.	B.	Images unsteady.
79	" "	8	ν Scorpii . . .	10	20.71	231.77	P.	B.	Images 60'' apart.
80	" "	8	σ Scorpii . . .	10	33.14	136.76	P.	B.	
81	" "	8	Jupiter IV, II . .	10	40.19	140.99	P.	B.	
82	" "	8	β Capricorni . .	10	17.12	321.60	P.	B.	[β Capricorni, C.
83	" "	9	α Capricorni . .	10	5.34	322.08	P.	B.	Nos. 83-87. Probably
84	" "	9	" . . .	10	5.42	50.74	C.	B.	Observer, A. G. Clark.
85	" "	10.3	" . . .	10	4.66	140.14	P.	B.	Centre of field.
86	" "	10.4	" . . .	10	7.46	136.38	P.	B.	Right of field.
87	" "	10.5	" . . .	10	5.95	145.21	P.	B.	Left of field.
88	Aug. 22	7.9	" . . .	10	40.99	49.91	P.	(B.)	Images 2½' apart.
89	" "	8.2	β Capricorni . .	10	14.09	50.09	P.	(B.)	
90	" "	8.4	α Ursæ Majoris .	10	6.16	229.80	P.	(B.)	
91	" "	8.6	α Libræ . . .	10	19.51	228.73	P.	(B.)	
92	" "	8.7	" . . .	10	21.16	52.44	P.	(B.)	
93	" "	8.8	ν Scorpii . . .	10	13.43	141.43	P.	(B.)	
94	" "	9.0	β Capricorni . .	10	10.55	140.41	P.	(B.)	
95	" "	9.3	α Ursæ Majoris .	2	4.85	318.45	P.	(B.)	
96	" "	9.5	" " . . .	10	5.00	316.92	P.	(B.)	
97	" "	9.6	" " . . .	10	4.67	137.81	P.	(B.)	
98	Aug. 27	9	Jupiter II, A 1 . .	4	47.17	165.32	P.	B.	Right eye.
99	" "	9	" II, A 1 . .	4	45.97	161.77	P.	B.	Left eye.
100	" "	9	" II, A 1 . .	4	42.70	164.80	P.	B.	Right eye.
101	" "	9	" II, A 1 . .	4	46.22	162.37	P.	B.	Left eye.
102	" "	9.5	Tethys . . .	4	16.50	166.90	P.	B.	Right eye.
103	" "	9.6	" . . .	4	16.10	165.50	P.	B.	Left eye; Tethys reddish
104	" "	9.8	Titan . . .	2	54.00		P.	B.	Zero not determined.
105	" "	10.0	Rhea . . .	9	13.92	254.00	P.	B.	
106	" "	10.5	Saturn, Mars . .	2	12.90	181.50	P.	[C.]	
107	" "	11	Deimos, A 1 . . .	5	4.30	162.70	P.	B.	
108	" "	11	" A 1 . . .	10	3.90	161.98	S.	B.	
109	" "	11	" A 1 . . .	10	3.44	251.52	P.	B.	
110	" "	11	" A 1 . . .	10	4.88	72.17	U.	B.	
111	Aug. 28	9.2	Saturn, Mars . .	10	11.40	94.08	P.	[C.]	
112	" "	9.3	" " . . .	10	11.75	271.29	P.	[C.]	
113	" "	10.5	Deimos, B 1 . . .	10	2.61	202.61	R.	B.	} Obs., W. A. Rogers. Satellite seen 3 times. Observer, L. Waldo.
114	" "	11	" B 1 . . .	10	2.49	22.63	R.	B.	
115	" "	11	" B 1 . . .	9	2.61	49.86	P.	B.	
116	" "	11	" B 1 . . .	9	2.47	327.02	W.	B.	
117	" "	11	" B 1 . . .	2	3.00	328.60	P.	B.	
118	Aug. 30	11	Saturn, Mars . .	10	11.40	178.88	P.	[C.]	
119	" "	11	" " . . .	10	10.40	90.72	P.	[C.]	
120	" "	11	Deimos, c 4 . . .	16	1.04	120.14	R.	B.	Observer, W. A. Rogers.
Total Number . .				1035					

PHOTOMETRIC OBSERVATIONS.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
121	Aug. 30	12.0	Saturn, Mars . .	11	10.97	89.69	P.	[C.]	
122	" "	12.1	" " . .	10	12.69	271.01	P.	[C.]	
123	Aug. 31	0.3	D 3, D 4	4	12.50	208.75	P.	B.	
124	" "	0.5	D 2, D 3	10	6.63	209.37	P.	B.	
125	" "	1	D 2, D 4	10	2.15	119.73	P.	B.	
126	" "	1	D 3, D 4	10	13.00	120.30	P.	B.	
127	" "	23.6	Shade-glass . . .	10	2.32	90.02	P.	B.	Measures of absorption.
128	Sept. 1	0	" "	10	2.23	270.85	P.	B.	
129	" "	0	" "	10	1.66	89.82	P.	B.	Second plate.
130	" "	0	" "	10	1.85	270.57	P.	B.	
131	Sept. 2	9.8	Rhea, Titan . . .	10	29.09	.47	P.	B.	Both objects faint.
132	Sept. 3	9.8	Saturn, Mars . . .	10	12.67	228.21	P.	[C.]	
133	" "	10.0	" "	10	12.87	357.77	P.	[C.]	Index O.
134	" "	10.2	" "	10	13.05	269.15	P.	[C.]	Index V.
135	Sept. 4	9.2	Deimos	10	9.39	254.73	P.	D.	Satellite bluish.
136	" "	9.5	" "	10	7.70	72.80	P.	D.	
137	" "	10.7	Mars, J 1	10	13.62	5.70	P.	D.	{ For constant. J. 5 (?). Apert. 12.7 cms.
138	" "	10.8	" J 1	10	12.62	182.98	P.	D.	
139	" "	11.0	Deimos	12	9.41	254.09	P.	D.	
140	" "	11.2	" "	10	8.68	72.60	P.	D.	
141	" "	11.6	" "	10	8.40	73.74	S.	D.	Mars redder than Deimos
142	" "	11.9	Deimos, M 2 . . .	10	4.17	90.97	P.	B.	
143	" "	23	Artificial Star . .	12	33.14	167.29	P.	[D.]	For constant.
144	" "	23	" "	10	63.34		S.	[D.]	Zero not determined.
145	Sept. 5	6.5	" "	12	46.25	165.55	P.	[D.]	
146	Sept. 6	4.8	" "	4	31.35	181.65	P.	[D.]	
147	" "	5	" "	10	33.74	180.48	P.	[D.]	
148	" "	5	" "	10	32.15	1.39	P.	[D.]	
149	" "	5	" "	10	22.19	.87	P.	[C.]	
150	" "	5	" "	10	24.61	87.49	P.	[C.]	{ Aperture .94 cms.
151	" "	5	" "	10	40.06	251.50	P.	[C.]	
152	" "	5	" "	10	30.22	265.42	P.	[C.]	
153	Sept. 9	7.0	Jupiter, Q 1 . . .	10	30.81	5.61	P.	D.	
154	" "	8	" Q 1	10	23.43	183.05	P.	D.	{ For constant. Aper- ture 12.7 cms.
155	" "	8	Mars, Q 1	10	37.23	266.43	P.	D.	
156	" "	8	" Q 1	6	30.85	89.82	P.	D.	
157	" "	8	" Q 1	11	39.69	97.09	P.	D.	
158	" "	9.2	Deimos	10	8.55	182.73	P.	D.	
159	" "	9.3	" "	10	9.92	3.02	P.	D.	
160	" "	9.8	" "	10	8.52	2.44	S.	D.	Mars redder than Deimos
161	" "	9.9	" "	10	9.91	181.67	P.	D.	
162	" "	10.3	" "	10	9.33	182.29	P.	D.	[grayish.
163	" "	10.5	" "	10	10.72	2.75	S.	D.	Mars reddish, Deimos
164	" "	11.0	Mars, Q 1	10	42.19	181.89	P.	D.	{ For constant. Aper- ture 12.7 cms.
165	" "	11.3	" Q 1	4	31.65	262.20	P.	D.	
166	" "	11.5	Phobos	10	8.33	1.55	P.	D.	
167	" "	11.7	Deimos	10	8.45	2.51	P.	D.	Mars decidedly red.
168	" "	12.0	Phobos	10	9.40	182.86	S.	D.	
169	" "	12.2	Deimos	10	10.05	181.37	S.	D.	
170	Sept. 10	10.3	Mars, Q 1	10	25.99	183.85	P.	D.	{ For constant. Aper- ture 7.65 cms.
171	" "	10.5	" Q 1	10	39.65	3.09	P.	D.	
172	" "	11.0	Zero	12		182.00	P.	[D.]	
173	Sept. 11	7.8	Jupiter, Q 1 . . .	10	19.90	2.30	P.	D.	{ For constant. Aper- ture 7.65 cms.
174	" "	8.0	" Q 1	10	18.15	179.35	P.	D.	
175	" "	8.1	Jupiter II	10	33.50	4.02	P.	D.	Aperture 7.65 cms. Sat- ellite hazy.
176	" "	8.3	Mars, Q 1	10	19.90	3.80	P.	D.	{ For constant. Aper- ture 7.65 cms.
177	" "	8.4	" Q 1	10	21.45	181.02	P.	D.	
178	" "	8.5	" Q 1	10	26.62	178.65	S.	D.	
179	" "	9.8	Phobos	10	10.52	2.80	P.	D.	Field illuminated.
180	" "	10.3	" "	2	15.1	4.4	P.	D.	Field brighter, browner.
Total Number . .				1615					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
181	Sept. 11	10.4	Tethys	10	62.05	2.43	P.	D.	
182	" "	10.5	"	2	60.25	172.65	P.	D.	[7.65 cms.
183	Sept. 12	8	Mars, R 3	10	20.08	2.24	P.	D.	For constant. Aperture
184	" "	8.4	" R 3	10	15.78	181.26	P.	D.	Apert. 7.65 cms. Clouds.
185	" "	9.0	" R 3	10	50.29	179.25	S.	D.	Aperture 12.7 cms.
186	" "	9.5	Phobos	10	6.52	1.88	P.	D.	Mars in bluer field than
187	" "	9.7	Deimos	10	5.83	2.05	P.	D.	Phobos.
188	" "	10.5	"	12	6.30	2.17	P.	D.	
189	" "	10.8	"	10	8.68	1.92	S.	D.	
190	" "	11.2	"	10	8.86	1.82	P.	D.	Mars in dark field.
191	" "	11.4	Mars, R 3	8	27.74	1.66	P.	D.	
192	Sept. 13	7.3	Jupiter, R 1	10	21.75	182.59	P.	D.	
193	" "	7.4	" R 1	10	21.73	1.77	P.	D.	For constant. Aper-
194	" "	7.7	Mars, R 1	10	28.17	1.29	P.	D.	ture 12.7 cms.
195	" "	7.8	" R 1	10	26.26	182.54	P.	D.	
196	" "	8.3	Enceladus	10	34.87	4.33	P.	D.	
197	" "	8.4	"	10	31.14	359.90	S.	D.	
198	" "	8.9	Deimos	10	7.33	2.23	P.	D.	198-200. Mars in dark
199	" "	9.0	"	10	8.61	2.69	S.	D.	field.
200	" "	10.3	" R 3	10	5.44	261.12	P.	C.	Satellite very faint.
201	" "	10.8	"	10	6.57	1.65	P.	D.	201-205. Mars in bright
202	" "	11.1	"	10	7.41	1.75	S.	D.	field.
203	" "	11.3	Phobos	10	9.22	1.76	S.	D.	Phobos > Deimos.
204	" "	11.5	"	10	8.87	1.33	P.	D.	
205	" "	11.7	Deimos	10	8.84	2.08	P.	D.	
206	Sept. 15	9.2	Star, Mars	10	8.86	1.40	P.	D.	Star, supposed at the
207	" "	9.3	" "	10	7.24	181.58	P.	D.	time to be Antiope.
208	" "	9.4	" "	10	14.56	181.72	S.	D.	Star yellowish-white.
209	" "	9.6	" "	8	14.50	2.25	S.	D.	
210	Sept. 16	10.2	Antiope, Mars	10	13.28	2.16	P.	D.	
211	" "	10.3	" "	10	18.16	3.10	S.	D.	
212	" "	10.4	" "	10	10.67	181.27	P.	D.	
213	" "	10.5	" "	12	15.56	181.38	S.	D.	
214	" "	11.5	Deimos, Saturn	10	35.87	.31	P.	D.	
215	" "	11.6	" "	10	29.60	4.92	S.	D.	
216	" "	11.7	Phobos	10	11.97	1.61	P.	D.	
217	" "	11.8	Deimos	10	8.96	1.52	P.	D.	
218	" "	11.9	"	10	8.88	181.18	P.	D.	
219	Sept. 18	9.4	Antiope, Saturn	10	30.74	1.96	P.	D.	Objects dim.
220	" "	9.5	" "	3	42.10	1.40	R.	D.	{ Obs., W. A. Rogers,
221	" "	9.6	" "	10	38.06	.40	R.	D.	{ Refocussed before 221
222	" "	9.9	" "	10	35.64	.50	S.	D.	[colored.
223	" "	10.3	Antiope, Mars	10	9.04	181.42	P.	D.	Mars in bright field, not
224	" "	10.4	" "	10	7.61	1.37	S.	D.	Field of Mars too dark.
225	" "	23.6	Sky	10	34.05	359.67	P.	D.	225-228. For constant.
226	Sept. 19	0.0	"	10	36.09	2.41	S.	D.	Aperture 12.7 cms.
227	" "	0.0	"	10	32.03	182.47	P.	D.	Field limited by dia-
228	" "	0.0	"	10	35.92	181.64	S.	D.	phragm. [12.7 cms.
229	" "	7.6	Jupiter, R 3	10	31.48	359.94	P.	D.	For constant. Aperture
230	Sept. 22	6.3	" R 3	10	17.19	181.15	P.	D.	
231	" "	6.5	" R 3	10	15.54	1.68	P.	D.	
232	" "	7.8	Mars, R 3	10	16.50	180.54	P.	D.	For constant. Aper-
233	" "	8.2	" R 3	10	24.95	1.63	S.	D.	ture 7.65 cms.
234	" "	8.5	" R 3	10	21.82	359.50	P.	D.	
235	" "	8.6	" R 3	10	25.11	181.71	S.	D.	
236	" "	9	Zero	5		181.64	S.	D.	
237	" "	9	"	5		1.16	S.	D.	
238	" "	9	"	5		181.76	P.	D.	By Moon.
239	" "	9	"	5		1.52	P.	D.	
240	Sept. 23	6.3	Jupiter IV, III	10	24.02	177.02	P.	B.	Index V.
Total Number . .				2180					

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
241	Sept. 23	6.4	Jupiter II, I . . .	10	44.52	89.18	P.	B.	Rhea and Dione not separated.
242	" "	8.2	Rhea + Dione, Titan	10	24.36	358.18	P.	B.	
243	" "	8.3	" " "	10	21.36	177.74	S.	B.	
244	" "	8.8	Rhea + Dione, R 3	2	34.40	182.80	P.	B.	
245	" "	9.0	" " R 3	10	30.10	359.10	P.	B.	
246	" "	9.1	" " R 3	10	45.03	3.23	S.	B.	
247	" "	9.5	Rhea + Dione, Mars	10	19.22	181.26	P.	D.	
248	" "	9.6	" " "	10	19.89	180.99	S.	D.	[colored. Mars in bright field, not Mars yellowish, Deimos bluish-gray.
249	" "	9.9	Tethys, Mars . . .	10	17.96	1.78	P.	D.	
250	" "	10.0	" " . . .	10	15.67	.85	S.	D.	
251	" "	10.5	Deimos	10	10.16	181.56	P.	D.	
252	" "	10.7	" "	10	14.25	183.11	S.	D.	
253	Sept. 24	6.0	Jupiter II, R 3 . . .	12	24.16	356.90	P.	B.	
254	" "	6.3	" I, R 3	10	25.64	177.16	P.	B.	
255	" "	6.6	" IV, I	10	39.75	91.37	P.	B.	
256	" "	7.3	Iapetus, Mars . . .	10	15.53	.93	P.	D.	
257	" "	7.4	Titan, Mars	10	45.72	4.24	P.	D.	
258	" "	7.6	Tethys, Mars	10	13.99	2.61	P.	D.	} Star mistaken for Deimos.
259	" "	7.8	Enceladus, Mars . .	10	7.43	1.47	P.	D.	
260	" "	8.0	Rhea, Mars	10	22.74	2.22	P.	D.	
261	" "	8.1	Dione, Mars	10	17.34	3.32	P.	D.	
262	" "	8.7	Tethys, Mars	10	15.17	181.85	P.	D.	
263	" "	8.8	" "	10	13.66	183.08	S.	D.	
264	" "	9.0	Titan, Mars	10	33.97	181.53	P.	D.	
265	" "	9.1	" "	10	35.08	185.88	S.	D.	
266	" "	9.3	Iapetus, Mars . . .	10	15.46	1.28	P.	D.	
267	" "	9.4	" "	10	16.51	.99	S.	D.	
268	" "	9.9	Star, Mars	10	9.30	1.14	P.	D.	} Saturn through tele- scope of D.
269	" "	10.0	" "	10	9.48	1.50	P.	D.	
270	" "	10.1	" "	10	7.23	180.19	S.	D.	
271	Sept. 25	6.2	Jupiter I, III . . .	10	40.17	179.57	P.	(B.)	
272	" "	6.3	" IV, II	5	29.18	178.01	P.	(B.)	
273	" "	6.5	" IV, II	10	40.86	177.56	P.	(B.)	
274	" "	7.2	Star, Jupiter III . .	10	18.70	86.98	P.	(B.)	
275	" "	7.3	Jupiter I, III . . .	10	38.39	358.87	P.	(B.)	
276	" "	8.7	Tethys, Mars	10	16.36	.88	P.	D.	
277	" "	8.8	" "	10	16.42	.74	S.	D.	} For constant. Aper- ture 12.7 cms. } Aperture 7.65 cms.
278	" "	9.0	Rhea, Mars	10	20.94	1.66	P.	D.	
279	" "	9.1	" "	10	25.20	1.42	S.	D.	
280	Sept. 26	9.3	Titan	10	43.03	232.57	P.	C.	
281	" "	9.5	" "	10	28.59	228.27	S.	C.	
282	" "	10.6	Saturn, Mars	10	14.88	221.86	P.	[C.]	
283	" "	10.7	" "	10	13.41	41.83	P.	[C.]	
284	Sept. 27	22.9	Sky	10	41.44	94.48	P.	D.	
285	" "	23.0	" "	10	39.65	94.59	P.	D.	
286	" "	23.2	" "	10	24.06	95.46	P.	D.	} Star near Iapetus.
287	" "	23.4	" "	11	24.91	94.99	P.	D.	
288	Sept. 29	6.1	Jupiter IV, III . . .	10	31.06	67.78	P.	B.	
289	" "	7.0	" II, I	10	40.80	245.98	P.	B.	
290	" "	7.3	" IV, II	10	36.47	141.55	P.	B.	
291	" "	7.8	Rhea, Titan	10	26.86	232.38	P.	B.	
292	Sept. 30	7.9	Jupiter II, I	10	43.09	165.95	P.	B.	
293	" "	9.8	Saturn, Mars	10	13.09	259.45	P.	[B.]	
294	" "	9.9	" "	10	16.46	357.24	S.	[B.]	
295	" "	10.1	" "	10	13.74	353.80	P.	[B.]	
296	" "	10.2	" "	10	16.45	261.25	S.	[B.]	} Star near Iapetus.
297	Oct. 1	7.5	Star, Saturn	5	17.828		P.	E.	
298	" "	7.8	Tethys	5	19.826		P.	E.	
299	" "	7.8	" "	5	19.690		P.	E.	
300	" "	8.0	" "	5	20.790		U.	E.	
Total Number . . .				2750					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
301	Oct. 1	8.1	Tethys	5	20.636		U.	E.	
302	" "	8.3	"	5	19.522		S.	E.	
303	" "	8.5	"	5	19.712		S.	E.	
304	" "	8.6	Hyperion	5	17.122		P.	E.	} Still fainter object suspected.
305	" "	8.9	"	5	18.254		S.	E.	
306	" "	9.1	"	5	16.856		U.	E.	
307	" "	9.3	Tethys	5	20.212		P.	E.	} Alternate readings.
308	" "	9.3	Dione	5	19.268		P.	E.	
309	" "	9.3	Rhea	5	21.518		P.	E.	
310	" "	9.3	Hyperion	1	17.28		P.	E.	} Saturn in dark field. Alternate readings.
311	" "	9.4	Tethys	5	20.226		S.	E.	
312	" "	9.4	Dione	5	19.316		S.	E.	
313	" "	9.4	Rhea	5	20.744		S.	E.	} Saturn in bright field. Alternate readings.
314	" "	9.8	Tethys	5	20.986		U.	E.	
315	" "	9.8	Dione	5	20.120		U.	E.	
316	" "	9.8	Rhea	5	21.420		U.	E.	} Saturn in bright field. Alternate readings.
317	" "	9.8	Hyperion	1	17.95		U.	E.	
318	" "	10.0	"	6	17.033		P.	E.	
319	" "	10.3	"	2	17.830		S.	E.	} Result of discussion.
320	" "	23.5	Zero	1		15.768	P.	[E.]	
321	Oct. 3	23	"	5		14.735	P.	[E.]	
322	" "	23	"	1		14.734	P.	[E.]	} 323 & 324, alt. readgs. Saturn in bright field. Faint star seen near.
323	Oct. 5	7.5	Hyperion	5	16.354		P.	E.	
324	" "	7.5	Iapetus	5	20.080		P.	E.	
325	" "	7.7	Hyperion	5	15.748		U.	E.	} Images of same object compared.
326	" "	8.4	Saturn, Mars	10	15.51	173.15	P.	[C.]	
327	" "	8.5	" "	10	42.86	173.02	U.	[C.]	
328	" "	8.7	" "	10	13.51	174.19	S.	[C.]	} Readjusted.
329	" "	8.8	" "	10	16.70	171.96	U.	[C.]	
330	" "	8.8	Dione	4	17.578		P.	E.	
331	" "	9.0	"	5	18.032		P.	E.	} Satellite blurred.
332	" "	9.1	"	5	18.248		S.	E.	
333	" "	9.2	"	5	18.094		U.	E.	
334	" "	9.4	Hyperion	5	16.268		P.	E.	} Definition poor.
335	" "	9.5	"	5	16.106		S.	E.	
336	" "	9.8	Dione, Titan	10	25.85	318.71	P.	B.	
337	" "	10.1	" "	10	28.49	138.13	U.	B.	} Right centre of field. Left centre of field.
338	" "	10.3	" "	6	27.43	319.20	S.	B.	
339	Oct. 6	6.9	Jupiter II, III	10	35.92	263.22	P.	B.	
340	" "	7.1	" II, III	10	33.27	84.97	P.	B.	} Field bright. [Saturn. Vesta more yellow than Hazy, perhaps more so about Vesta.
341	Oct. 7	8.9	Vesta, Saturn	5	21.246		P.	E.	
342	" "	9.0	" "	5	22.092		S.	E.	
343	" "	9.2	" "	5	21.628		P.	E.	} For constant.
344	" "	9.3	" "	5	20.406		S.	E.	
345	" "	9.7	Enceladus	5	17.628		P.	E.	
346	" "	9.8	"	5	18.086		S.	E.	} Aperture 12.7 cms.
347	" "	10.0	Titan	5	25.586		P.	E.	
348	" "	10.1	"	5	22.864		S.	E.	
349	" "	10.2	Iapetus	5	18.648		P.	E.	} For constant.
350	" "	10.3	"	5	18.876		S.	E.	
351	Oct. 8	1.2	Sky	5	32.442		P.	E.	
352	" "	1.2	"	5	20.502		P.	E.	} The readings of sets 356, 358, 361, 362, and even numbers to 382 inclusive, were increasing and taken alternately with the
353	" "	1.3	"	5	20.136		P.	E.	
354	" "	7	Zero	5		14.729	P.	[E.]	
355	" "	23.8	Artificial Star	5	26.754		P.	[E.]	} For constant.
356	" "	23.9	" "	5	25.888		S.	[E.]	
357	" "	23.9	" "	5	27.476		S.	[E.]	
358	Oct. 9	0.3	" "	5	27.724		U.	[E.]	} For constant.
359	" "	0.3	" "	5	28.590		U.	[E.]	
360	" "	0.6	" "	5	27.760		P.	[E.]	
Total Number . .				3072					

PHOTOMETRIC OBSERVATIONS.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
361	Oct. 9	0.6	Artificial Star . .	5	27.626		P.	[E.]	decreasing readings of the other sets between 355 and 384.
362	" "	0.9	" " . .	5	24.594		S.	[E.]	
363	" "	0.9	" " . .	5	25.828		S.	[E.]	
364	" "	1.4	" " . .	5	18.492		P.	[E.]	
365	" "	1.4	" " . .	5	18.542		P.	[E.]	} Left eye.
366	" "	1.5	" " . .	5	19.058		S.	[E.]	
367	" "	1.5	" " . .	5	19.050		S.	[E.]	
368	" "	22.5	" " . .	5	18.418		P.	[E.]	
369	" "	22.5	" " . .	5	18.518		P.	[E.]	} Left eye.
370	" "	22.7	" " . .	5	18.308		S.	[E.]	
371	" "	22.7	" " . .	5	18.454		S.	[E.]	
372	" "	22.9	" " . .	5	18.640		U.	[E.]	
373	" "	22.9	" " . .	5	18.742		U.	[E.]	} Left eye.
374	Oct. 10	0.0	" " . .	5	29.572		S.	[E.]	
375	" "	0.0	" " . .	5	29.916		S.	[E.]	
376	" "	0.2	" " . .	5	27.750		P.	[E.]	
377	" "	0.2	" " . .	6	27.325		P.	[E.]	Direct image large.
378	" "	0.6	" " . .	5	19.702		P.	[E.]	
379	" "	0.6	" " . .	5	19.646		P.	[E.]	
380	" "	0.6	" " . .	5	19.738		S.	[E.]	
381	" "	0.6	" " . .	5	19.968		S.	[E.]	
382	" "	0.9	" " . .	5	20.198		U.	[E.]	
383	" "	0.9	" " . .	5	20.262		U.	[E.]	
384	" "	11.3	Saturn, Mars . .	10	16.15	264.07	P.	[C.]	
385	" "	11.4	" " . .	10	14.93	82.47	P.	[C.]	
386	Oct. 13	1.0	α Leonis, Sun . .	5	15.822		P.	E.	
387	" "	1.1	" " . .	5	15.782		P.	E.	
388	" "	1.2	" " . .	5	20.962		P.	E.	
389	" "	1.3	" " . .	5	20.468		P.	E.	
390	" "	1.4	" " . .	6	19.962		P.	E.	
391	" "	6.2	Jupiter II . . .	5	24.870		P.	E.	
392	" "	6.4	" III . . .	5	31.616		P.	E.	
393	" "	6.8	" IV . . .	5	26.963		P.	E.	
394	" "	7.0	" II . . .	5	21.498		U.	E.	
395	" "	7.2	" II . . .	5	25.726		P.	E.	
396	" "	7.3	" III . . .	5	32.726		P.	E.	
397	" "	7.4	" IV . . .	5	24.450		P.	E.	
398	" "	7.5	Titan . . .	5	25.646		P.	E.	
399	" "	7.6	Iapetus . . .	5	19.094		P.	E.	
400	" "	7.7	" . . .	5	19.472		U.	E.	For constant.
401	" "	7.8	Titan . . .	5	22.622		U.	E.	
402	" "	8	Saturn, R 3 . . .	5	22.404		P.	E.	
403	" "	9.0	Rhea . . .	5	19.616		P.	E.	
404	" "	9.1	Tethys . . .	5	18.536		P.	E.	Dione and Tethys appear equal.
405	" "	9.3	" . . .	5	19.026		U.	E.	
406	" "	9.5	Rhea . . .	5	20.610		U.	E.	
407	" "	9.7	Saturn, R 3 . . .	5	22.672		U.	E.	
408	" "	9.9	Dione . . .	5	18.692		U.	E.	For constant. Dione a little fainter than Tethys.
409	" "	10.0	Enceladus . . .	5	16.876		U.	E.	
410	" "	10.3	" . . .	5	16.874		P.	E.	
411	" "	10.3	Dione . . .	5	19.132		P.	E.	
412	" "	10.4	Saturn, Mars . .	10	16.86	82.52	P.	[C.]	} Alternate readings.
413	" "	10.5	" " . .	10	13.96	83.64	P.	[C.]	
414	Oct. 14	8.7	Deimos, Saturn . .	1	16.44		P.	E.	
415	" "	8.8	" " . .	5	16.212		P.	E.	
416	Oct. 15	5.8	Jupiter I, III . .	10	42.84	129.60	P.	B.	Doubtful, omit. Clouds.
417	" "	6	" I, E 2 . .	10			P.	B.	
418	Oct. 17	6.6	" II . .	5	19.104		P.	E.	
419	" "	6.6	" I . .	5	18.482		P.	E.	
420	" "	6.7	" I . .	5	18.384		P.	E.	} Aperture 12.7 cms.
Total Number . .				3400					

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
421	Oct. 17	6.7	Jupiter IV . . .	5	17.348		P.	E.	Aperture 12.7 cms. No. 425, Saturn in field.
422	" "	6.9	" III . . .	5	21.264		P.	E.	
423	" "	7.0	Titan . . .	5	18.962		U.	E.	
424	" "	7.1	Rhea . . .	5	17.242		U.	E.	
425	" "	7.3	Dione . . .	5	16.558		U.	E.	
426	" "	8.3	Saturn, Mars . .	10	17.50	30.274	M.	[B.]	Obs., C. H. Metcalf.
427	" "	8.4	" " . . .	9	16.82	300.92	M.	[B.]	
428	" "	8.8	Rhea . . .	5	20.184		P.	E.	Alternate readings.
429	" "	8.8	Tethys . . .	5	18.798		P.	E.	
430	" "	8.9	Iapetus . . .	5	17.368		P.	E.	Iapetus at 8h. 53m. in conjunction with following ansa.
431	" "	8.9	Enceladus . . .	5	17.310		P.	E.	
432	" "	9.0	Dione . . .	5	17.292		P.	E.	Close to ansa.
433	" "	9.1	Titan . . .	5	25.966		P.	E.	Image of Saturn put out of focus.
434	" "	9.3	Rhea . . .	5	19.386		U.	E.	
435	" "	9.4	Tethys . . .	5	18.098		U.	E.	
436	" "	9.5	Enceladus . . .	5	16.654		U.	E.	
437	" "	9.5	Saturn, Moon . .	10	4.44	32.92	P.	[B.]	
438	" "	9.5	Mars, Moon . .	10	13.15	34.05	P.	[B.]	
439	" "	9.7	Saturn, Mars . .	10	17.65	31.89	P.	[B.]	
440	" "	9.7	Dione . . .	5	17.732		U.	E.	
441	" "	9.8	Iapetus . . .	5	17.378		U.	E.	
442	" "	10.0	Titan . . .	5	26.570		U.	E.	
443	" "	10.2	Saturn, R 3 . . .	5	22.564		P.	E.	For constant.
444	" "	10.3	" R 3 . . .	5	22.366		U.	E.	Passing cirrus cloud.
445	Oct. 18	6.5	Jupiter IV, I . .	10	33.66	14.58	P.	B.	
446	" "	6.7	" IV, I . . .	10	34.38	121.70	U.	B.	
447	" "	6.8	" IV, II . . .	2	43.35	27.85	U.	B.	
448	" "	8.5	Mars, R 3 . . .	5	23.112		P.	E.	For constant. Passing clouds.
449	" "	8.6	" R 3 . . .	5	22.414		U.	E.	
450	" "	8.8	Saturn, R 3 . . .	5	23.004		P.	E.	For constant.
451	" "	9.5	Mimas . . .	1	17.30		P.	E.	As recollected.
452	" "	9.6	Iapetus . . .	1	18.54		P.	E.	
453	" "	9.6	Rhea . . .	1	21.02		P.	E.	Focus changed.
454	" "	9.7	Iapetus . . .	5	17.462		P.	E.	Alternate readings.
455	" "	9.7	Rhea . . .	5	19.544		P.	E.	
456	" "	9.7	Saturn, Mars . .	10	15.92	274.78	U.	[B.]	Clouds.
457	" "	9.8	Mars, Moon . .	10	12.29	45.77	U.	[B.]	
458	" "	10.1	Saturn, Moon . .	10	3.27	45.07	U.	[B.]	
459	" "	10.3	" Mars . . .	10	15.20	226.86	P.	[B.]	
460	Oct. 22	6.4	Titan . . .	5	22.698		P.	E.	
461	" "	7.5	Iapetus . . .	5	18.000		P.	E.	
462	" "	7.6	Dione . . .	7	18.604		P.	E.	Alternate readings.
463	" "	7.6	Rhea . . .	5	20.330		P.	E.	
464	" "	7.7	Enceladus . . .	3	17.337		P.	E.	
465	" "	9.3	Saturn, Mars . .	10	18.10	217.06	P.	[C.]	
466	" "	9.4	" " . . .	10	19.01	218.57	U.	[C.]	
467	" "	10.2	Neptune, Moon N 1	5	15.192		P.	E.	
468	" "	10.2	" " N 1	5	15.220		U.	E.	
469	" "	10.3	" " N 1	5	15.298		P.	E.	
470	" "	10.6	" " O 1	5	16.562		P.	E.	
471	" "	10.7	" " O 1	5	16.712		P.	E.	Moon moved for each setting.
472	Oct. 23	5.2	Zero . . .	5		14.767	P.	[E.]	
473	" "	5.3	Sky . . .	5	20.730		P.	E.	For constant. Aperture [12.7 cms.]
474	" "	5.4	Jupiter III . . .	5	19.326		P.	E.	
475	" "	5.6	" I . . .	5	18.466		P.	E.	
476	" "	5.7	" II . . .	5	18.176		P.	E.	
477	" "	5.8	" IV . . .	5	17.650		P.	E.	
478	" "	6.0	" II . . .	5	18.484		U.	E.	
479	" "	6.1	" I . . .	5	18.640		U.	E.	
480	" "	6.3	" III . . .	5	18.922		U.	E.	
Total Number . .				3749					

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
481	Oct. 23	6.4	Jupiter IV . . .	5	17.458		U.	E.	
482	" "	6.5	" IV . . .	6	17.435		P.	E.	
483	" "	6.6	" I . . .	5	18.500		P.	E.	
484	" "	6.7	" III . . .	5	19.062		P.	E.	
485	" "	6.8	" II . . .	5	18.790		P.	E.	
486	" "	6.8	Star, Jupiter . . .	5	16.068		P.	E.	Star s. f. Jupiter.
487	" "	7.6	Vesta, Saturn . . .	5	21.514		P.	E.	Aperture 12.7 cms. Saturn out of focus in No. 488.
488	" "	7.6	" " . . .	5	22.278		U.	E.	
489	" "	7.8	" Mars . . .	5	17.560		U.	E.	
490	" "	8.0	" " . . .	5	17.926		P.	E.	
491	" "	8.2	Saturn, Mars . . .	12	17.09	306.76	P.	[C.]	Companion barely visible, clouds.
492	" "	9.5	" " . . .	10	19.63	36.79	U.	[C.]	
493	" "	9.8	" " . . .	10	19.52	36.08	P.	[C.]	
494	Oct. 24	7.7	α Lyrae . . .	5	.15	110.06	P.	B.	
495	" "	22.0	Zero . . .	5		14.743	P.	[E.]	For constant. Aperture 12.7 cms.
496	" "	22.1	Sky . . .	5	20.360		P.	E.	
497	" "	22.6	" . . .	5	21.668		U.	E.	
498	" "	22.8	" . . .	5	20.470		P.	E.	
499	Oct. 25	2.0	" . . .	5	20.518		P.	E.	Aperture 7.65 cms. [low.]
500	" "	2.2	" . . .	5	21.864		U.	E.	
501	" "	2.3	" . . .	5	18.514		P.	E.	
502	" "	2.4	" . . .	5	18.816		U.	E.	
503	Oct. 27	5.9	Jupiter, Venus . . .	10	25.03	307.27	P.	[C.]	Objects distant, Venus Images close together.
504	" "	9.6	Saturn, Mars . . .	10	19.52	36.32	P.	[C.]	
505	" "	9.7	" " . . .	7	19.04	128.21	S.	[C.]	
506	" "	10.3	" " . . .	10	17.86	306.88	P.	[C.]	
507	Oct. 28	5.7	Jupiter, Venus . . .	10	24.07	35.13	P.	[C.]	Saturn very faint and blurred.
508	" "	5.8	" " . . .	10	27.61	35.19	S.	[C.]	
509	" "	9.8	Saturn, Mars . . .	10	18.39	215.49	P.	[C.]	
510	" "	10.1	" " . . .	10	20.65	308.17	S.	[C.]	
511	Oct. 29	7.3	" " . . .	10	20.62	35.36	U.	[C.]	Hazy.
512	" "	8.1	π Andromedæ . . .	10	6.52	212.06	P.	B.	
513	Oct. 30	5.8	Saturn, Mars . . .	10	18.49	36.41	P.	[C.]	
514	" "	6.2	" " . . .	10	17.26	35.88	U.	[C.]	
515	" "	7.3	Antiope, Saturn . . .	5	16.864		P.	E.	Less weight than last set.
516	" "	7.4	" Mars . . .	5	15.604		P.	E.	
517	" "	7.5	" " . . .	5	15.654		U.	E.	
518	" "	7.6	" Saturn . . .	5	16.890		U.	E.	
519	" "	7.8	Hyperion . . .	5	16.866		P.	E.	Between clouds, but seen well.
520	" "	7.9	" . . .	5	16.914		U.	E.	
521	" "	8.9	Saturn, Mars . . .	10	21.62	214.92	S.	[C.]	
522	Nov. 1	5.4	Jupiter, Venus . . .	10	23.87	35.19	P.	[C.]	
523	" "	5.5	Zero . . .	5		14.739	P.	[E.]	Nov. 3. Seeing, 8, 8, 5. Objects too close.
524	Nov. 3	5.6	Jupiter, Venus . . .	10	20.96	126.38	S.	[C.]	
525	" "	5.7	Saturn, Mars . . .	10	13.61	218.93	S.	[C.]	
526	" "	5.9	Zero, by gas-flame . . .	5		217.10	S.	[C.]	
527	" "	6.0	" by Venus . . .	10	4.88	215.60	S.	[C.]	[of visibility. Image reduced to limit Nov. 4. Seeing, 5, 8, 5.
528	Nov. 4	5.8	Jupiter, Venus . . .	10	24.00	35.32	S.	[C.]	
529	" "	5.9	Saturn, Mars . . .	10	14.49	127.91	S.	[C.]	
530	" "	6.0	Zero . . .	10		124.38	S.	[C.]	
531	Nov. 6	5.6	Jupiter, Venus . . .	10	19.22	124.12	S.	[C.]	Nov. 6. Seeing, 8, 8, 5.
532	" "	5.8	Saturn, Mars . . .	10	17.79	215.07	S.	[C.]	
533	" "	6.0	Zero . . .	10		125.98	S.	[C.]	
534	" "	6.3	Jupiter, Venus . . .	10	24.36	218.88	U.	[C.]	
535	" "	8.9	Saturn, Mars . . .	10	19.48	127.52	P.	[C.]	Thro' closed window.
536	" "	9.0	" " . . .	10	19.93	35.77	P.	[C.]	
537	Nov. 7	2.7	Sky . . .	5	20.788		P.	E.	
538	" "	5.4	Jupiter, Venus . . .	10	19.72	126.90	P.	[C.]	
539	" "	5.6	" " . . .	10	22.37	36.05	P.	[C.]	Index O.
540	" "	5.7	" " . . .	10	21.51	36.31	S.	[C.]	Index O 225°.
Total Number . .				4209					

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
541	Nov. 7	5.9	Jupiter, Venus .	10	19.09	125.97	S.	[C.]	{ Index V, 225°.
542	" "	6.2	" " .	10	21.13	126.03	U.	[C.]	
543	" "	6.3	" " .	10	23.54	215.38	U.	[C.]	
544	" "	6.6	Mars, R 3 . . .	5	22.428		P.	E.	Index O, 225°.
545	" "	6.8	" R . . .	5	17.120		S.	E.	For constant.
546	" "	7.1	" R 3 . . .	5	23.288		U.	E.	Probably not R 3.
547	" "	7.3	" R 3 . . .	5	23.282		P.	E.	
548	" "	7.9	Iapetus . . .	5	17.242		P.	E.	Nov. 7. Seeing rather bad.
549	" "	8.0	Hyperion . . .	5	15.928		P.	E.	
550	" "	8.1	Dione . . .	5	19.000		P.	E.	
551	" "	8.2	Iapetus . . .	5	17.636		U.	E.	
552	" "	8.3	Dione . . .	5	18.764		U.	E.	
553	" "	8.5	Hyperion . . .	5	16.080		U.	E.	
554	" "	8.5	Saturn, Mars . .	10	19.63	215.51	P.	[C.]	Index O, 90°.
555	" "	8.7	Iapetus . . .	5	18.892		S.	E.	
556	" "	8.9	Hyperion . . .	5	16.228		S.	E.	
557	" "	9.0	Dione . . .	5	18.076		S.	E.	
558	" "	9.1	Saturn, Mars . .	10	21.99	36.77	U.	[C.]	Index V, 225°.
559	" "	10.2	Brunhild, β Arietis	5	19.138		S.	E.	
560	" "	10.3	" " .	5	19.770		P.	E.	
561	" "	10.4	" " .	5	22.662		U.	E.	
562	Nov. 9	5.8	Jupiter, Venus .	10	19.71	126.45	P.	[C.]	Index V.
563	" "	5.9	" " .	10	20.89	36.21	P.	[C.]	Index O.
564	" "	6.2	Saturn, Mars . .	10	20.30	35.90	P.	[C.]	Index O. Images almost
565	" "	6.3	Jupiter, Venus .	10	20.65	36.43	P.	[C.]	Index O. [superposed.
566	" "	6.4	" " .	10	22.12	306.52	P.	[C.]	Index V.
567	" "	6.6	" " .	10	22.41	306.83	S.	[C.]	Index V, 180°.
568	" "	6.7	" " .	10	25.25	215.39	S.	[C.]	{ Index O, 180°.
569	" "	6.7	" " .	10	24.80	216.20	U.	[C.]	
570	" "	6.8	" " .	10	22.67	125.53	U.	[C.]	Index V, 180°.
571	Nov. 13	4.8	Sky . . .	5	20.594		P.	E.	For const. Ap. 12.7 cms.
572	" "	4.8	" . . .	5	32.066		P.	E.	Full aperture.
573	" "	5.5	Venus . . .	17			P. S.	E.	Artificial satellite.
574	" "	6.0	Jupiter, Venus .	10	19.45	123.75	S.	[C.]	Index V, 135°.
575	" "	6.1	" " .	10	20.59	213.71	S.	[C.]	{ Index O, 135°.
576	" "	6.2	" " .	10	20.21	214.35	U.	[C.]	
577	" "	6.3	" " .	10	18.40	122.70	U.	[C.]	Index V, 135°.
578	" "	6.3	β Capricorni, CD .	5	18.724		P.	E.	Nov. 13. Clear, seeing
579	" "	6.3	Jupiter, Venus .	10	19.90	123.20	P.	[C.]	Index V, 135°. [good.
580	" "	6.4	" " .	10	20.69	206.31	P.	[C.]	Index O, 135°.
581	" "	6.4	β Capricorni, CD .	5	18.640		S.	E.	Clock not working. B less blue than A. B yellowish, A bluish.
582	" "	6.6	" " CD .	5	17.710		U.	E.	
583	" "	7.2	α Lyrae . . .	5	18.868		P.	E.	
584	" "	7.3	" " .	5	18.352		U.	E.	
585	" "	7.5	ϵ Lyrae E, α Lyrae .	5	18.810		P.	E.	
586	" "	7.6	" F, " .	5	15.932		P.	E.	
587	" "	7.6	" G, " .	5	16.338		P.	E.	
588	" "	7.9	" E, " .	5	18.792		U.	E.	
589	" "	8.0	" F, " .	5	15.658		U.	E.	
590	" "	8.0	" G, " .	5	16.154		U.	E.	
591	" "	8.2	" E, " .	5	19.846		S.	E.	
592	" "	8.3	" F, " .	5	17.026		S.	E.	
593	" "	8.3	" G, " .	5	16.424		S.	E.	
594	" "	8.8	β Delphini, c . .	5	20.982		S.	E.	A in field.
595	" "	9.0	" " B . .	5	27.166		S.	E.	A out of field.
596	" "	9.1	Mars, Moon . .	10	19.01	197.17	P.	[C.]	{ Index O, 135°.
597	" "	9.2	" " .	10	20.01	335.97	P.	[C.]	
598	" "	9.2	β Delphini, B . .	5	30.354		U.	E.	A out of field.
599	" "	9.3	Mars, Moon . .	10	14.17	254.47	S.	[C.]	Index O, 225°.
600	" "	9.3	β Delphini, c . .	5	20.484		U.	E.	A in field.
Total Number . .				4636					

PHOTOMETRIC OBSERVATIONS.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
601	Nov. 13	9.6	Mars, Moon . .	10	29.71	163.27	S.	[C.]	Index O, 225°.
602	" "	9.6	β Delphini, c . .	5	20.818		P.	E.	
603	" "	9.7	" B . .	5	29.376		P.	E.	
604	" "	9.9	Mars, Moon . .	10	21.51	334.55	U.	[C.]	Index V, 225°.
605	" "	9.9	α Pegasi, c . .	5	22.616		P.	E.	
606	" "	10.0	Mars, Moon . .	10	18.96	59.54	U.	[C.]	Index O, 225°.
607	" "	10.0	α Pegasi, c . .	6	22.182		S.	E.	
608	Nov. 14	22.0	Zero	5		14.745	P.	[E.]	
609	" "	22.2	Sky	5	20.802		P.	E.	For const. Ap. 12.7 cms. No. 609, right eye. No. 610, left eye. Inserted circular diaphragm after No. 611.
610	" "	22.2	"	5	20.492		P.	E.	
611	" "	22.3	"	5	21.786		U.	E.	
612	" "	22.5	"	5	21.574		P.	E.	
613	" "	23.1	"	5	21.072		S.	E.	
614	" "	23.1	"	5	20.706		P.	E.	
615	Nov. 15	0.2	Artificial Star . .	5	26.524		P.	[E.]	For constant.
616	" "	0.3	" "	3	28.420		S.	[E.]	
617	" "	0.8	" "	5	27.096		P.	[E.]	
618	" "	0.9	" "	5	27.614		S.	[E.]	
619	" "	1.2	" "	5	27.080		U.	[E.]	
620	" "	2.5	" "	5	24.800		P.	[E.]	
621	" "	2.6	" "	5	24.070		S.	[E.]	
622	" "	2.7	" "	5	18.910		P.	[E.]	
623	" "	2.8	" "	5	18.888		S.	[E.]	
624	" "	2.9	" "	5	18.980		P.	[E.]	
625	" "	3.0	" "	5	19.088		S.	[E.]	
626	Nov. 16	9.0	Iapetus	5	16.768		P.	E.	
627	" "	9.1	Saturn, Mars . .	10	26.44	236.60	S.	[C.]	Index O, 270°.
628	" "	9.1	Tethys	5	19.180		P.	E.	
629	" "	9.2	Saturn, Mars . .	10	25.23	326.99	S.	[C.]	Index V, 270°.
630	" "	9.2	Tethys	5	19.490		U.	E.	
631	" "	9.3	Saturn, Mars . .	10	27.30	146.50	P.	[C.]	Index O, 90°.
632	" "	9.3	Iapetus	5	17.472		U.	E.	
633	" "	9.3	Saturn, Mars . .	10	24.09	236.53	P.	[C.]	Index V, 90°.
634	" "	9.5	γ Orionis	10	4.71	263.89	P.	(F.)	For constant.
635	" "	9.8	"	4	6.22	264.42	S.	(F.)	
636	Nov. 17	6.2	Jupiter, Venus . .	10	14.61	236.55	P.	[C.]	Index V, 135°.
637	" "	6.2	" "	10	15.38	327.66	P.	[C.]	Index O, 135°.
638	" "	6.7	β Aquarii, B . .	5	22.092		P.	E.	
639	" "	6.8	" B	5	21.952		S.	E.	
640	" "	7.1	α Aquarii	5	19.480		P.	E.	B bluer than A.
641	" "	7.2	" "	5	20.422		S.	E.	
642	Nov. 18	6.5	Saturn, Mars . .	8	24.69	238.99	S.	[C.]	Index O, 270°.
643	" "	6.5	" "	8	28.45	145.60	S.	[C.]	Index V, 270°.
644	" "	6.9	Neptune, Moon . .	5	15.094		P.	E.	Moon moved for each setting.
645	" "	7.0	" "	5	15.138		S.	E.	
646	" "	7.2	" "	5	15.136		P.	E.	
647	" "	9.1	Vesta, Mars . . .	5	17.964		P.	E.	
648	" "	9.2	" "	5	17.952		S.	E.	
649	" "	9.3	" "	5	17.756		P.	E.	Aperture 12.7 cms.
650	" "	9.4	" Saturn	5	21.408		P.	E.	
651	" "	9.5	" "	5	21.204		S.	E.	
652	" "	9.9	Saturn, Mars . .	8	25.83	236.58	P.	[C.]	Index V, 90°.
653	" "	9.9	" "	8	27.67	145.69	P.	[C.]	Index O, 90°.
654	Nov. 19	4.8	Sky	5	20.480		P.	E.	For const. Ap. 12.7 cms.
655	" "	4.9	"	5	31.696		P.	E.	
656	" "	7.8	χ Cygni k, α Cygni	5	22.686		P.	E.	Comparison stars for χ Cygni.
657	" "	7.9	" l, "	5	20.054		P.	E.	
658	" "	8.1	" n, "	5	18.586		P.	E.	
659	" "	8.2	" m, "	5	18.710		P.	E.	
660	" "	8.3	" c, "	5	19.882		P.	E.	
Total Number . .				4996					

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
661	Nov. 19	8.4	χ Cygni g, α Cygni	5	18.352		P.	E.	
662	" "	8.7	Enceladus . . .	5	17.410		P.	E.	
663	" "	8.8	Iapetus . . .	5	17.634		P.	E.	
664	" "	8.9	Hyperion . . .	5	16.386		P.	E.	
665	" "	9.0	Enceladus . . .	5	17.244		P.	E.	
666	" "	9.2	Iapetus . . .	5	16.184		U.	E.	Hazy.
667	" "	9.4	Tethys . . .	5	17.736		U.	E.	Saturn in field.
668	" "	9.5	Iapetus . . .	5	16.598		S.	E.	
669	" "	9.7	Tethys . . .	5	16.764		S.	E.	
670	" "	9.9	Titan . . .	5	17.810		U.	E.	
671	" "	9.9	" . . .	5	18.294		S.	E.	} Aperture 12.7 cms.
672	" "	10.0	" . . .	5	17.860		P.	E.	
673	Nov. 20	4.8	Sky . . .	5	32.764		P.	E.	For constant.
674	" "	6.0	Iapetus . . .	5	16.446		S.	E.	
675	" "	6.2	Tethys . . .	5	16.146		S.	E.	
676	" "	6.4	" . . .	5	18.432		P.	E.	
677	" "	6.5	Iapetus . . .	5	16.806		P.	E.	
678	" "	7.2	χ Cygni e, α Cygni	4	16.65	263.40	P.	F.	
679	" "	7.3	" e, "	4	16.27	264.37	P.	F.	
680	" "	7.4	" k, "	4	32.97	263.92	P.	F.	
681	" "	7.5	" l, "	4	48.40	265.20	P.	F.	
682	" "	7.6	" n, "	4	28.72	354.22	P.	F.	
683	" "	7.7	" m, "	4	29.95	355.05	P.	F.	Poor, discordant.
684	" "	7.8	" i, "	4	51.22	353.13	P.	F.	
685	" "	7.9	" g, "	4	43.20	353.85	P.	F.	
686	" "	8.0	" c, "	4	21.50	84.00	P.	F.	
687	" "	8.1	" h, "	4	11.65	84.85	P.	F.	
688	" "	8.2	" d, "	4	21.77	82.72	P.	F.	
689	" "	8.3	" η , "	4	8.40	83.70	P.	F.	
690	" "	8.4	α Cygni . . .	10	2.18	83.28	P.	F.	For constant.
691	Nov. 21	23.5	Zero . . .	5		14.664	P.	[E.]	
692	Nov. 22	0.8	" . . .	5		14.671	P.	[E.]	
693	" "	3.8	" . . .	5		14.666	P.	[E.]	
694	" "	3.9	" . . .	5		14.726	P.	[E.]	[screw. Turned pin holding
695	Nov. 28	9.7	α Piscium . . .	4	31.15	159.95	P.	C.	Incomplete sets of S.
696	" "	9.8	" . . .	4	32.37	161.67	S.	C.	and U. rejected.
697	" "	9.9	" . . .	4	30.85	162.70	U.	C.	
698	Nov. 30	4.5	Zero . . .	5		.001	P.	[G.]	
699	" "	4.9	Sky . . .	5	2.143		P.	G.	} For constant. Aper- ture 12.7 cms.
700	" "	5.0	" . . .	5	2.176		P.	G.	
701	" "	6.6	Iapetus . . .	5	1.271		S.	G.	Saturn partly concealed.
702	" "	6.7	" . . .	5	1.030		U.	G.	Saturn in full view.
703	" "	6.8	Rhea . . .	5	1.168		S.	G.	
704	" "	6.9	Titan . . .	5	1.522		S.	G.	
705	" "	7.2	Rhea . . .	5	1.015		U.	G.	
706	" "	7.8	α Delphini B . . .	5	2.402		P.	G.	
707	" "	7.9	" C . . .	2	1.730		P.	G.	
708	" "	7.9	" D . . .	5	2.462		U.	G.	2.52 rejected.
709	" "	8.0	" E . . .	2	1.280		P.	G.	Clouds.
710	" "	8.3	" B . . .	4	2.290		U.	G.	
711	Dec. 1	3.9	Zero . . .	5		— .001	P.	[G.]	
712	" "	4.0	Sky . . .	5	1.747		P.	G.	For const. Ap. 12.7 cms.
713	" "	6.8	Iapetus . . .	5	1.058		S.	G.	Saturn in field.
714	" "	6.9	Titan . . .	5	2.412		S.	G.	Dec. 1. Clear, but see-
715	" "	7.0	Tethys . . .	5	1.696		S.	G.	ing not good.
716	" "	7.5	Iapetus . . .	5	1.130		U.	G.	
717	" "	7.8	Rhea . . .	5	1.352		U.	G.	
718	" "	7.9	Iapetus . . .	5	1.158		P.	G.	
719	" "	8.0	Rhea . . .	5	1.850		P.	G.	
720	" "	8.4	β Delphini c . . .	5	2.426		P.	G.	B too bright to measure.
Total Number . .				5279					

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
721	Dec. 1	8.7	γ Equulei . . .	5	2.700		P.	G.	
722	" "	8.9	" " " " . . .	5	5.016		S.	G.	
723	" "	9.4	ϵ Pegasi c . . .	5	1.250		S.	G.	
724	" "	9.5	" " c . . .	5	1.352		P.	G.	
725	" "	9.7	α Aquarii . . .	5	2.006		P.	G.	
726	" "	10.0	" " " " . . .	5	2.280		S.	G.	
727	Dec. 2	6.6	ϵ Lyræ . . .	4	31.82	157.12	P.	H.	Dec. 2. Clear, seeing tolerable.
728	" "	6.7	" " " " . . .	4	33.50	147.50	P.	H.	
729	" "	6.8	" " " " . . .	4	32.02	240.33	S.	H.	
730	" "	6.8	" " " " . . .	4	34.10	238.30	S.	H.	
731	" "	7.0	δ Lyræ . . .	4	52.75	152.60	S.	H.	37.25 (?)
732	" "	8.3	α Cygni B . . .	5	.834		P.	G.	
733	" "	8.4	α Cygni . . .	1	.303		P.	G.	Limit of visibility.
734	" "	8.5	α Cygni B . . .	5	.838		S.	G.	
735	" "	8.6	α Cygni . . .	1	.371		S.	G.	Limit of visibility.
736	" "	9.4	ϵ Pegasi c . . .	5	.986		S.	G.	
737	" "	9.5	" " c . . .	5	1.046		P.	G.	
738	" "	9.6	" " d . . .	5	.652		P.	G.	
739	" "	9.8	ξ Pegasi c . . .	1	2.42		P.	G.	
740	" "	10.1	β Pegasi . . .	5	1.040		P.	G.	
741	" "	10.2	" " " " . . .	5	1.052		S.	G.	Thermometer 18° at 10%.
742	Dec. 3	4.8	Sky . . .	5	1.905		P.	G.	{ For constant. Aper-
743	" "	4.9	" " " " . . .	5	2.138		S.	G.	{ ture 12.7 cms.
744	" "	5.2	ζ Lyræ . . .	4	29.82	149.42	P.	H.	Images in line.
745	" "	5.3	" " " " . . .	4	29.10	149.00	P.	H.	
746	" "	5.5	" " " " . . .	4	29.20	150.85	S.	H.	
747	" "	5.8	39 Draconis A, c . .	4	14.17	238.87	P.	H.	
748	" "	5.8	" " A, c . .	4	16.67	238.82	S.	H.	
749	" "	6.1	α Draconis . . .	4	12.82	238.77	P.	H.	
750	" "	6.2	" " " " . . .	4	15.50	239.55	S.	H.	
751	" "	6.2	" " " " . . .	4	11.40	239.75	U.	H.	
752	" "	6.7	α Aquilæ . . .	5	1.953		U.	G.	
753	" "	7.2	γ Aquilæ . . .	5	1.510		P.	G.	
754	" "	7.5	" " " " . . .	5	1.554		U.	G.	
755	" "	8.0	α^2 Cygni B, α Cygni .	5	.416		P.	G.	
756	" "	8.1	" " B, " " . . .	5	.578		U.	G.	
757	" "	8.7	ζ Pegasi B, α Pegasi .	5	.887		U.	G.	
758	" "	8.9	" " B, " " . . .	5	.744		S.	G.	
759	" "	9.2	ξ Pegasi c, " " . .	5	.732		S.	G.	
760	" "	9.5	" " c, " " . . .	5	1.175		U.	G.	
761	" "	8.8	δ Orionis . . .	4	6.62	251.07	P.	(H.)	Discordant, α probably in penumbra of prism.
762	" "	8.9	" " " " . . .	4	6.87	250.57	P.	(H.)	
763	Dec. 4	23.6	Artificial Star . . .	5	3.266		P.	[G.]	
764	" "	23.7	" " " " . . .	5	3.998		S.	[G.]	For constant. Readings of Nos. 765-788 alternately increasing and decreasing. Nos. 766, 767, odd numbers to 779, 782, 784, 785, 787, have incr. readings.
765	" "	23.9	" " " " . . .	5	3.894		S.	[G.]	
766	" "	23.9	" " " " . . .	5	3.736		S.	[G.]	
767	Dec. 5	0.2	" " " " . . .	5	3.548		P.	[G.]	
768	" "	0.2	" " " " . . .	5	3.612		P.	[G.]	
769	" "	1.1	" " " " . . .	5	3.244		S.	[G.]	{ Right eye.
770	" "	1.1	" " " " . . .	5	3.484		S.	[G.]	
771	" "	1.5	" " " " . . .	5	3.256		S.	[G.]	{ Left eye.
772	" "	1.5	" " " " . . .	5	3.566		S.	[G.]	
773	" "	1.8	" " " " . . .	5	3.226		S.	[G.]	{ Right eye.
774	" "	1.8	" " " " . . .	5	3.518		S.	[G.]	
775	" "	2.3	" " " " . . .	5	3.294		S.	[G.]	{ Left eye.
776	" "	2.3	" " " " . . .	5	3.376		S.	[G.]	
777	" "	2.6	" " " " . . .	5	3.378		U.	[G.]	
778	" "	2.6	" " " " . . .	5	3.608		U.	[G.]	
779	" "	3.1	" " " " . . .	5	3.804		P.	[G.]	
780	" "	3.1	" " " " . . .	5	3.702		P.	[G.]	
Total Number . . .				5552					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
781	Dec. 5	3.2	Artificial Star . .	3	3.400		P.	[G.]	
782	" "	3.2	" " . .	3	3.420		P.	[G.]	
783	" "	21.9	" " . .	5	3.424		P.	[G.]	
784	" "	21.9	" " . .	5	3.526		P.	[G.]	
785	" "	22.1	" " . .	5	3.480		S.	[G.]	
786	" "	22.1	" " . .	5	3.730		S.	[G.]	
787	" "	22.4	" " . .	5	3.674		P.	[G.]	
788	" "	22.4	" " . .	5	3.648		P.	[G.]	
789	Dec. 7	5.8	1 Pegasi	4	6.17	162.22	S.	H.	
790	" "	5.8	" "	4	4.75	161.55	P.	H.	
791	" "	5.9	" "	4	6.25	162.60	P.	H.	
792	" "	5.9	" "	4	5.25	161.05	S.	H.	
793	" "	6.4	η Lyræ	4	11.22	251.12	S.	H.	
794	" "	6.5	" "	4	10.12	251.32	U.	H.	
795	" "	6.6	" "	4	10.97	251.47	U.	H.	
796	" "	6.7	" "	4	12.15	252.05	S.	H.	Somewhat hazy.
797	" "	7.1	52 Cygni	4	7.85	161.05	S.	H.	
798	" "	7.2	" "	4	6.30	161.30	U.	H.	
799	" "	7.3	" "	2	6.85	249.65	U.	H.	
800	" "	8.2	f^1 Cygni	4	6.30	161.25	U.	H.	
801	" "	8.3	" "	2	6.60	72.60	U.	H.	Clouds.
802	" "	9.8	" "	4	6.42	161.47	S.	H.	Images dim & unsteady.
803	" "	9.9	" "	4	7.12	161.62	P.	H.	
804	" "	10.0	" "	4	7.10	161.35	S.	H.	
805	" "	10.1	" "	4	7.10	161.15	P.	H.	
806	Dec. 8	6.2	β Cygni	4	20.75	161.80	S.	H.	A orange, B blue.
807	" "	6.3	" "	4	22.70	161.15	P.	H.	Thin clouds.
808	" "	6.4	" "	4	21.80	164.00	S.	H.	
809	" "	6.5	" "	4	19.00	164.80	U.	H.	
810	" "	6.5	" "	4	20.35	164.15	U.	H.	Seeing much worse.
811	" "	6.6	" "	4	23.72	162.77	P.	H.	
812	" "	6.7	γ Delphini	4	34.42	163.82	P.	H.	
813	" "	6.7	" "	4	30.33	163.87	S.	H.	
814	" "	6.8	" "	4	31.30	163.80	P.	H.	
815	" "	6.9	" "	4	29.80	164.55	S.	H.	
816	" "	7.0	β Delphini	4	2.70	164.30	S.	H.	
817	" "	7.8	ζ Aquarii	4	38.78	162.87	P.	H.	
818	" "	7.9	" "	4	40.65	161.85	P.	H.	
819	" "	8.0	" "	4	45.40	161.75	U.	H.	
820	" "	8.1	" "	4	44.03	160.17	U.	H.	
821	" "	8.2	μ Cygni	4	28.20	160.70	P.	H.	
822	" "	8.2	" "	4	25.57	161.27	U.	H.	
823	" "	8.3	" "	4	25.90	161.40	U.	H.	
824	" "	8.4	" "	4	28.30	160.65	P.	H.	
825	" "	8.5	" "	4	26.45	161.75	S.	H.	
826	" "	8.7	ψ Cygni	4	21.37	161.22	P.	H.	
827	" "	8.8	" "	4	18.10	160.22	S.	H.	
828	" "	8.9	" "	4	16.27	161.57	U.	H.	
829	" "	9.0	" "	4	16.95	161.25	U.	H.	
830	" "	9.1	" "	4	15.90	161.05	S.	H.	
831	" "	9.2	" "	4	19.90	160.65	P.	H.	
832	Dec. 9	6.7	β Aquilæ B, α Aquilæ	5	.774		P.	I.	
833	" "	7.5	ε Lyræ E, α Lyræ .	5	1.112		P.	I.	
834	" "	7.5	" G, "	5	.264		P.	I.	
835	" "	7.6	" F, "	5	.306		P.	I.	
836	" "	7.7	" E, "	6	.790		P.	I.	Reject, dome interferes.
837	" "	7.8	" E, "	5	.956		P.	I.	
838	" "	7.9	α Lyræ	5	1.012		P.	I.	
839	" "	8.1	ζ Lyræ	4	31.83	163.62	P.	H.	
840	" "	8.2	" "	4	27.68	162.97	P.	H.	
Total Number . .				5800					

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
841	Dec. 9	8.4	α^2 Cygni B, α Cygni	5	.566		P.	I.	
842	" "	8.5	α Cygni B . . .	5	.808		P.	I.	
843	" "	8.6	" " . . .	5	.404		P.	I.	
844	" "	9.5	ϵ Cygni B . . .	5	1.500		P.	I.	Two more comp. seen.
845	" "	9.8	μ Cygni . . .	4	32.02	161.17	P.	H.	[tinue.
846	" "	9.9	" . . .	4	26.20	161.80	P.	H.	Seeing too bad to con-
847	Dec. 13	7.1	ϵ Lyræ . . .	4	30.60	143.85	P.	H.	Seeing very poor.
848	" "	7.2	ζ Lyræ . . .	4	25.10	184.85	P.	H.	
849	" "	7.3	" . . .	4	27.28	186.22	P.	H.	
850	" "	7.3	" . . .	4	29.30	186.25	U.	H.	
851	" "	7.3	" . . .	4	27.73	186.37	U.	H.	
852	" "	7.4	" . . .	4	22.05	184.80	U.	H.	
853	" "	7.8	μ Cygni . . .	4	22.55	183.80	U.	H.	High wind.
854	" "	7.9	" . . .	4	22.17	185.67	U.	H.	
855	" "	8.2	ξ Cephei . . .	4	23.87	185.27	U.	H.	
856	" "	8.2	" . . .	4	22.62	183.62	S.	H.	
857	" "	8.3	" . . .	4	21.87	184.12	S.	H.	
858	" "	8.4	" . . .	4	7.65	187.05	S.	H.	
859	" "	8.5	β Cephei . . .	4	8.55	185.80	S.	H.	
860	" "	8.6	" . . .	4	7.27	185.72	U.	H.	
861	" "	8.6	" . . .	4	6.80	185.45	U.	H.	Clouds passing.
862	" "	8.7	" . . .	4	19.87	186.22	U.	H.	
863	" "	8.9	δ Cephei . . .	4	21.50	187.35	U.	H.	
864	" "	9.0	" . . .	4	17.92	186.17	S.	H.	
865	" "	9.0	" . . .	4	17.55	186.60	S.	H.	
866	" "	9.1	" . . .	4	11.10	187.60	S.	H.	
867	" "	9.4	π Cephei . . .	4	11.70	186.22	S.	H.	
868	" "	9.5	" . . .	4	10.77	185.92	U.	H.	
869	" "	9.6	" . . .	4	10.50	186.30	U.	H.	Clouds passing.
870	" "	9.6	" . . .	4	8.35	185.05	U.	H.	
871	" "	9.8	η Cassiopeia . . .	4	8.55	185.20	U.	H.	
872	" "	9.9	" . . .	4	9.25	184.75	S.	H.	
873	" "	9.9	" . . .	4	9.12	185.22	S.	H.	
874	" "	10.0	" . . .	4	9.30	186.15	P.	H.	
875	Dec. 14	5.3	η Lyræ . . .	4	9.70	185.50	S.	H.	
876	" "	5.3	" . . .	4	10.28	185.52	P.	H.	
877	" "	5.4	" . . .	4	9.08	186.42	S.	H.	
878	" "	5.4	" . . .	4	15.10	185.05	S.	H.	
879	" "	5.7	α Draconis . . .	4	14.32	185.17	S.	H.	Left eye.
880	" "	5.8	" . . .	4	10.75	186.15	P.	H.	
881	" "	5.8	" . . .	4	9.95	185.95	P.	H.	
882	" "	5.9	" . . .	4	12.95	181.65	C.	H.	Observer, A. G. Clark.
883	" "	6.0	" . . .	4	8.30	180.15	P.	H.	
884	" "	6.4	f^1 Cygni . . .	4	8.02	179.77	S.	H.	
885	" "	6.5	" . . .	4	7.20	182.20	S.	H.	Left eye.
886	" "	6.6	" . . .	4	8.52	180.17	U.	H.	
887	" "	6.6	" . . .	4	9.10	179.20	U.	H.	Seeing now very bad.
888	" "	6.7	" . . .	4	12.12	181.77	S.	H.	
889	" "	7.1	δ^1 Piscium . . .	4	11.32	181.82	S.	H.	Left eye.
890	" "	7.1	" . . .	4	11.75	180.20	U.	H.	
891	" "	7.2	" . . .	4	10.70	180.35	U.	H.	
892	" "	7.3	" . . .	4	9.52	184.67	P.	H.	
893	" "	7.5	" . . .	4	9.75	183.75	P.	H.	New Nicol in photometer.
894	" "	7.6	" . . .	4	31.87	184.42	P.	H.	
895	" "	7.6	ζ Piscium . . .	4	32.52	184.67	P.	H.	
896	" "	7.7	" . . .	4	33.60	183.05	U.	H.	
897	" "	7.7	" . . .	4	34.57	184.67	U.	H.	
898	" "	7.8	" . . .	4	41.57	184.37	P.	H.	
899	" "	7.9	ψ^1 Piscium . . .	4	41.25	183.15	P.	H.	
900	" "	7.9	" . . .	4	39.20	182.25	U.	H.	
Total Number . .				6044					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
901	Dec. 14	8.0	ψ^1 Piscium . . .	4	40.95	181.90	U.	H.	
902	" "	8.2	55 Piscium . . .	4	12.62	183.32	P.	H.	Left eye. Comp. bluish.
903	" "	8.2	" . . .	4	11.10	183.35	P.	H.	Right eye.
904	" "	8.2	" . . .	4	11.15	183.75	S.	H.	
905	" "	8.3	" . . .	4	11.42	183.57	S.	H.	Left eye.
906	" "	8.4	" . . .	4	12.77	183.57	U.	H.	
907	" "	8.4	" . . .	4	12.15	183.35	U.	H.	
908	" "	8.7	φ Piscium . . .	4	5.42	184.17	U.	H.	
909	" "	8.8	" . . .	4	4.97	184.17	U.	H.	
910	" "	8.8	" . . .	4	5.20	94.20	S.	H.	} Clouds.
911	" "	9.0	" . . .	4	4.72	94.22	S.	H.	Left eye.
912	" "	9.1	" . . .	4	5.62	183.72	P.	H.	
913	" "	9.1	" . . .	4	6.00	184.20	P.	H.	
914	" "	9.2	γ Arietis . . .	4	45.07	181.82	P.	H.	
915	" "	9.2	" . . .	4	47.22	181.92	P.	H.	
916	" "	9.3	" . . .	4	49.38	183.82	U.	H.	
917	" "	9.4	" . . .	4	47.93	183.52	U.	H.	
918	" "	9.5	" . . .	4	46.20	183.80	S.	H.	Seeing bad.
919	" "	9.6	" . . .	4	45.75	185.35	S.	H.	Left eye.
920	" "	9.7	ι Trianguli . . .	4	26.37	183.62	S.	H.	
921	" "	9.8	" . . .	4	22.75	184.75	S.	H.	Left eye.
922	" "	9.8	" . . .	4	25.90	184.50	U.	H.	
923	" "	9.9	" . . .	4	23.50	184.50	U.	H.	
924	" "	10.0	" . . .	4	25.00	184.65	P.	H.	
925	" "	10.0	" . . .	4	26.32	185.22	P.	H.	Seeing poor.
926	Dec. 16	5.1	ζ Lyræ . . .	4	27.22	207.17	P.	H.	Dec. 16. Seeing about
927	" "	5.2	" . . .	4	28.02	207.42	P.	H.	7, 3, 3.
928	" "	5.3	" . . .	4	26.05	207.45	S.	H.	
929	" "	5.3	" . . .	4	25.00	208.50	S.	H.	
930	" "	5.4	η Lyræ . . .	4	8.57	116.92	P.	H.	
931	" "	5.5	" . . .	4	8.87	116.97	P.	H.	Reduced image larger
932	" "	5.5	" . . .	4	9.67	116.22	S.	H.	than B.
933	" "	5.6	" . . .	4	8.77	116.67	S.	H.	Left eye.
934	" "	5.7	39 Draconis Λ , C .	4	14.05	206.75	P.	H.	
935	" "	5.7	" Λ , C .	4	15.80	206.50	P.	H.	
936	" "	5.9	" Λ , C .	4	17.10	206.30	S.	H.	
937	" "	5.9	" Λ , C .	4	20.37	207.77	S.	H.	Left eye.
938	" "	6.1	θ Draconis . . .	4	10.85	206.55	P.	H.	
939	" "	6.1	" . . .	4	10.17	207.12	P.	H.	
940	" "	6.2	" . . .	4	12.27	205.52	S.	H.	
941	" "	6.3	" . . .	4	13.32	207.12	S.	H.	Left eye.
942	" "	6.4	ϵ Lyræ . . .	4	29.92	206.67	P.	H.	
943	" "	6.4	" . . .	4	31.40	204.80	P.	H.	
944	" "	6.5	" . . .	4	33.00	206.85	S.	H.	
945	" "	6.7	" . . .	4	35.87	206.47	S.	H.	Left eye.
946	" "	6.7	5 Lyræ . . .	4	40.80	207.40	S.	H.	
947	" "	6.9	" . . .	4	39.15	207.00	P.	H.	
948	" "	7.9	f^1 Cygni . . .	4	7.05	207.20	P.	H.	
949	" "	7.9	" . . .	4	6.80	207.55	P.	H.	
950	" "	8.1	μ Cygni . . .	4	26.32	118.22	P.	H.	
951	" "	8.2	" . . .	4	28.87	204.72	P.	H.	
952	" "	8.4	μ Cygni c . . .	5	2.832		P.	I.	
953	" "	8.6	" c . . .	5	2.912		S.	I.	Image hazy.
954	" "	9.0	Iapetus . . .	5	1.346		S.	I.	
955	" "	9.5	ζ Piscium . . .	4	31.47	207.17	P.	H.	
956	" "	9.6	" . . .	4	30.55	208.40	S.	H.	
957	" "	9.6	" . . .	4	33.55	206.45	P.	H.	Images interchanged.
958	" "	9.7	" . . .	4	32.27	206.87	S.	H.	Left eye.
959	" "	9.9	51 Piscium . . .	4	9.37	207.97	P.	H.	Images 150°.
960	" "	9.9	" . . .	4	10.42	207.92	S.	H.	
Total Number . .				6287					

PHOTOMETRIC OBSERVATIONS.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
961	Dec. 16	9.9	51 Piscium . . .	4	11.82	207.67	P.	H.	Images 300°. Left eye.
962	" "	10.0	" . . .	4	11.92	207.87	S.	H.	
963	Dec. 17	5.7	α Capricorni . . .	4	36.62	208.87	P.	H.	
964	" "	5.8	" . . .	4	38.05	207.45	P.	H.	
965	" "	5.9	β Capricorni . . .	4	12.67	207.92	P.	H.	
966	" "	6.0	" . . .	4	13.30	206.60	P.	H.	
967	" "	7.7	1 Pegasi . . .	4	5.05	250.10	P.	H.	
968	" "	7.8	" . . .	4	5.42	249.97	P.	H.	
969	" "	7.9	μ Cygni . . .	4	27.77	158.92	P.	H.	
970	" "	8.0	" . . .	4	28.40	157.65	P.	H.	
971	" "	8.6	α Piscium . . .	4	34.97	155.87	P.	H.	
972	" "	8.6	" . . .	4	32.40	156.60	P.	H.	
973	Dec. 18	5.1	ε Lyræ . . .	4	32.95	158.45	P.	H.	Dec. 18. Seeing about 5, 2, 7.
974	" "	5.2	" . . .	4	35.27	157.57	P.	H.	
975	" "	5.2	5 Lyræ . . .	4	44.70	157.80	P.	H.	
976	" "	5.3	" . . .	4	40.45	160.10	S.	H.	
977	" "	5.7	39 Draconis A, C . . .	4	16.12	248.02	S.	H.	
978	" "	5.7	" A, C . . .	4	17.92	247.47	P.	H.	
979	" "	5.8	" A, C . . .	4	16.55	247.75	S.	H.	Reversed images.
980	" "	5.9	" A, C . . .	4	15.77	246.52	P.	H.	Colors marked.
981	" "	6.0	β Cygni . . .	4	20.15	158.70	P.	H.	
982	" "	6.0	" . . .	4	18.87	158.27	S.	H.	
983	" "	6.1	" . . .	4	17.75	159.40	P.	H.	Reversed images.
984	" "	6.2	" . . .	4	20.07	158.87	S.	H.	} Through blue glass.
985	" "	6.3	" . . .	4	21.65	158.90	P.	H.	
986	" "	6.3	" . . .	4	23.77	159.82	S.	H.	
987	" "	6.4	" . . .	4	16.72	159.42	P.	H.	} Through red glass.
988	" "	6.4	" . . .	4	17.87	159.57	S.	H.	
989	Dec. 20	5.6	5 Lyræ . . .	4	41.80	162.75	S.	H.	
990	" "	5.7	" . . .	4	42.12	162.67	P.	H.	Dec. 20. Seeing variable.
991	" "	5.8	" . . .	4	42.60	163.70	S.	H.	
992	" "	6.0	" . . .	4	42.32	162.42	P.	H.	
993	" "	6.5	ψ Cygni . . .	4	16.35	161.65	S.	H.	
994	" "	6.6	" . . .	4	18.37	162.87	P.	H.	
995	" "	6.6	" . . .	4	18.37	162.87	S.	H.	
996	" "	6.7	" . . .	4	16.15	164.25	P.	H.	Reversed images.
997	" "	6.8	26 Cygni . . .	4	11.00	254.50	P.	H.	
998	" "	6.8	" . . .	4	9.02	252.92	P.	H.	
999	" "	6.9	" . . .	4	8.72	252.47	S.	H.	Reversed images.
1000	" "	7.0	" . . .	4	11.15	253.55	S.	H.	
1001	" "	8.5	ε Draconis . . .	4	11.40	162.50	S.	H.	
1002	" "	8.7	" . . .	4	11.95	162.65	S.	H.	Reversed images.
1003	" "	9.7	ν Ceti . . .	4	7.22	252.82	S.	H.	
1004	" "	9.7	" . . .	4	6.90	253.15	S.	H.	
1005	" "	10.0	γ Ceti . . .	4	18.55	163.20	S.	H.	Reversed images.
1006	" "	10.1	" . . .	4	15.07	163.37	S.	H.	
1007	Dec. 22	6.0	β Cygni . . .	4	20.22	166.72	P.	H.	
1008	" "	6.1	" . . .	4	20.65	165.85	P.	H.	Dec. 22. Seeing good, growing worse. Field of photometer H limited by inserting a diaphragm.
1009	" "	6.2	5 Lyræ . . .	4	42.85	168.05	P.	H.	
1010	" "	6.2	" . . .	4	42.32	166.92	P.	H.	
1011	" "	7.1	Tethys . . .	5	1.350		P.	I.	
1012	" "	7.8	Iapetus . . .	5	1.444		P.	I.	
1013	" "	7.9	Tethys . . .	5	1.288		P.	I.	
1014	" "	7.9	Iapetus . . .	5	1.248		P.	I.	Seeing much worse.
1015	" "	8.3	" . . .	5	1.336		S.	I.	
1016	" "	8.4	Tethys . . .	5	1.076		S.	I.	
1017	" "	8.5	ψ^1 Aquarii . . .	4	6.32	147.87	P.	H.	
1018	" "	8.6	" . . .	4	7.42	147.82	S.	H.	
1019	" "	8.7	" . . .	4	6.60	147.60	P.	H.	
1020	" "	8.7	" . . .	4	5.92	148.67	S.	H.	
Total Number . . .				6533					

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1021	Dec. 22	8.9	λ Arietis	4	18.40	237.50	P.	H.	
1022	" "	8.9	"	4	18.15	237.70	S.	H.	
1023	" "	9.0	"	4	17.62	147.27	P.	H.	
1024	" "	9.0	"	4	18.42	147.97	S.	H.	
1025	" "	9.1	γ Arietis	4	43.62	146.32	P.	H.	
1026	" "	9.1	"	4	45.70	147.80	S.	H.	
1027	" "	9.2	"	4	43.85	145.15	P.	H.	Half object-glass.
1028	" "	9.3	"	4	46.87	145.12	S.	H.	
1029	" "	9.5	π Arietis A, B . .	4	14.62	237.12	P.	H.	
1030	" "	9.6	" A, B . .	4	14.30	238.20	S.	H.	
1031	" "	9.7	" A, B . .	4	13.35	148.05	P.	H.	
1032	" "	9.8	" A, B . .	4	14.67	148.32	S.	H.	
1033	" "	9.9	" A, C . .	4	4.45	148.40	P.	H.	
1034	Dec. 23	5.2	26 Cygni	4	9.32	240.97	P.	H.	Dec. 23. Seeing good.
1035	" "	5.3	"	4	8.90	241.15	S.	H.	
1036	" "	5.4	"	4	9.95	241.40	P.	H.	Reversed images.
1037	" "	5.5	"	4	8.90	241.50	S.	H.	P. sees C 75°, 10" from B
1038	" "	5.6	ψ Cygni	4	14.30	240.10	P.	H.	
1039	" "	5.6	"	4	18.32	241.32	S.	H.	
1040	" "	5.7	"	4	18.57	240.02	P.	H.	Reversed images.
1041	" "	5.8	"	4	18.02	240.77	S.	H.	
1042	" "	6.2	Iapetus	5	1.366		P.	I.	
1043	" "	6.3	"	5	1.198		S.	I.	
1044	" "	6.7	Star b, Saturn . .	5	.562		P.	I.	
1045	" "	6.8	" a, "	2	.635		P.	I.	Stars near Deimos, Oct. 2d, 1878.
1046	" "	6.9	" b, "	5	.516		S.	I.	
1047	" "	7.0	" a, "	2	.645		S.	I.	Stars near Deimos, Aug. 17th, 1878.
1048	" "	8.7	" f, "	5	.752		P.	I.	
1049	" "	8.8	" g, "	2	1.125		P.	I.	
1050	" "	8.9	" f, "	5	.750		P.	I.	
1051	" "	9.2	ζ Piscium	4	33.42	152.47	P.	H.	
1052	" "	9.3	"	4	34.10	152.40	P.	H.	
1053	" "	9.4	51 Piscium	4	10.70	240.00	P.	H.	
1054	" "	9.5	"	4	10.95	239.70	P.	H.	
1055	" "	9.8	30 Tauri	4	8.77	238.97	P.	H.	
1056	" "	9.9	"	4	8.55	239.40	P.	H.	[at first than later.
1057	Dec. 24	5.3	5 Lyræ	4	42.52	148.87	S.	H.	Dec. 24. Seeing better
1058	" "	5.9	α Delphini	4	1.37	150.27	P.	H.	Too faint.
1059	" "	6.0	β Delphini	4	2.02	240.52	P.	H.	
1060	" "	6.1	γ Delphini	4	32.27	149.72	P.	H.	
1061	" "	6.2	"	4	33.00	149.95	P.	H.	
1062	" "	6.4	δ Equulei	4	3.85	150.30	P.	H.	
1063	" "	6.5	"	4	4.10	240.40	P.	H.	
1064	" "	7.2	ζ Aquarii	4	46.93	149.07	P.	H.	
1065	" "	7.3	"	4	41.42	149.42	P.	H.	
1066	" "	7.4	ψ^1 Aquarii	4	7.05	150.25	P.	H.	
1067	" "	7.5	"	4	6.95	240.35	P.	H.	
1068	" "	7.9	32 Eridani	4	29.15	152.20	P.	H.	A yellow, B blue.
1069	" "	8.0	"	4	25.75	238.15	P.	H.	
1070	" "	8.5	θ^1 Orionis A, B . .	4	28.82	149.97	S.	H.	
1071	" "	8.6	" A, C . .	4	32.17	149.62	S.	H.	
1072	" "	8.6	" A, D . .	4	16.17	238.97	S.	H.	
1073	" "	8.7	" B, C . .	4	40.42	148.47	S.	H.	
1074	" "	8.9	" B, D . .	4	32.90	148.95	S.	H.	
1075	" "	9.0	" C, D . .	4	27.25	240.65	S.	H.	
1076	" "	9.0	" A, B . .	4	25.62	239.62	P.	H.	
1077	" "	9.0	" A, C . .	4	26.10	239.85	P.	H.	
1078	" "	9.1	" A, D . .	4	16.12	239.62	P.	H.	
1079	" "	9.2	" B, C . .	4	45.25	151.05	P.	H.	
1080	" "	9.2	" B, D . .	4	33.05	149.50	P.	H.	
Total Number . .				6773					

PHOTOMETRIC OBSERVATIONS.

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1081	Dec. 24	9.3	θ^1 Orionis c, D. .	4	29.85	149.50	P.	H.	
1082	" "	9.4	" " A, C. .	4	28.62	149.47	S.	H.	
1083	" "	9.5	ι Orionis	4	6.97	149.22	S.	H.	
1084	" "	9.6	" "	4	6.90	148.60	P.	H.	
1085	" "	9.7	" "	4	7.15	239.50	P.	H.	
1086	" "	9.7	" "	4	7.12	239.42	S.	H.	
1087	" "	9.9	α Canis Majoris A, B	6	.40	330.97	P.	H.	
1088	Dec. 25	5.0	α Ursæ Minoris .	4	2.65	116.80	P.	H.	
1089	" "	5.0	" "	4	2.85	116.85	P.	H.	
1090	" "	5.1	" "	4	3.00	206.85	P.	H.	
1091	" "	5.2	" "	4	2.85	207.05	P.	H.	
1092	" "	5.6	π Cephei	4	9.27	206.12	P.	H.	A reddish.
1093	" "	5.7	" "	5	10.10	115.85	P.	H.	
1094	" "	5.9	β Cephei	4	6.52	116.52	P.	H.	
1095	" "	5.9	" "	4	7.22	206.32	P.	H.	
1096	" "	6.0	ξ Cephei	4	22.85	206.70	P.	H.	
1097	" "	6.1	" "	4	21.57	115.92	P.	H.	
1098	" "	6.2	δ Cephei	4	13.40	116.80	P.	H.	
1099	" "	6.3	" "	4	15.85	206.30	P.	H.	Dome covers half of ob- ject-glass.
1100	" "	7.9	ψ^1 Piscium	4	48.97	208.42	P.	H.	A very white, B green- ish.
1101	" "	8.0	" "	4	42.67	207.42	P.	H.	
1102	" "	8.1	55 Piscium	4	14.25	117.60	P.	H.	
1103	" "	8.2	" "	4	13.90	208.40	P.	H.	
1104	" "	8.2	" "	4	12.25	118.10	P.	H.	
1105	" "	8.3	ϕ Piscium	4	5.60	118.50	P.	H.	
1106	" "	8.4	" "	4	5.20	208.10	P.	H.	
1107	" "	8.5	γ Arietis	4	43.77	210.92	P.	H.	
1108	" "	8.6	" "	4	43.75	205.55	P.	H.	
1109	" "	9.0	ζ Orionis A, C . .	4	1.62	209.22	P.	H.	
1110	" "	9.1	" " A, C	4	1.67	119.12	P.	H.	
1111	" "	9.2	" " A, B	4	18.17	206.12	P.	H.	
1112	" "	9.4	δ Orionis	4	7.17	117.07	P.	H.	
1113	" "	9.5	" "	4	6.77	206.42	P.	H.	
1114	" "	9.6	β Orionis	4	2.77	116.22	P.	H.	
1115	" "	9.7	" "	5	2.85	205.70	P.	H.	
1116	" "	9.8	ι Leporis	4	5.87	116.77	P.	H.	
1117	" "	9.8	" "	4	5.07	206.12	P.	H.	
1118	" "	9.9	π Leporis	4	16.77	204.42	P.	H.	
1119	" "	9.9	" "	4	17.95	113.85	P.	H.	
1120	Dec. 26	5.6	Star near Venus .	6	4.028		P.	J.	
1121	" "	5.7	Venus	10			P.S.	J.	Artificial satellite.
1122	" "	6.0	β Delphini	4	3.40	116.80	S.	H.	
1123	" "	6.0	" "	4	2.12	116.87	P.	H.	
1124	" "	6.1	" "	4	2.90	206.60	P.	H.	
1125	" "	6.2	" "	4	2.77	206.57	S.	H.	
1126	" "	6.3	δ Equulei	4	3.55	206.90	P.	H.	
1127	" "	6.3	" "	4	3.62	117.07	P.	H.	
1128	" "	6.4	" "	4	3.90	117.30	S.	H.	
1129	" "	6.5	" "	4	4.10	207.20	S.	H.	
1130	" "	6.8	γ Delphini	4	35.02	205.97	S.	H.	A slightly orange, B white.
1131	" "	6.9	" "	4	31.85	205.90	S.	H.	
1132	" "	9.2	ζ Cancri AB, C . .	4	32.90	207.30	P.	H.	
1133	" "	9.2	" " AB, C	4	34.20	205.10	P.	H.	
1134	" "	9.7	β Cephei	4	7.27	116.12	P.	H.	
1135	" "	9.8	" "	4	8.27	116.17	S.	H.	
1136	" "	9.9	" "	4	7.25	206.55	S.	H.	
1137	" "	9.9	" "	4	6.72	205.97	P.	H.	
1138	" "	10.0	ε Draconis	4	13.60	205.35	P.	H.	
1139	" "	10.1	" "	4	14.90	206.60	S.	H.	
1140	" "	10.1	" "	4	12.02	116.52	P.	H.	
Total Number . .				7025					

No. for Reference.	Date, 1877.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo- meter.	Remarks.
1141	Dec. 26	10.2	ε Draconis . . .	4	13.00	116.15	S.	H.	
1142	Dec. 27	5.0	γ Delphini . . .	4	33.17	207.42	P.	H.	
1143	" "	5.0	" . . .	4	32.80	207.90	P.	H.	
1144	" "	5.3	α Lyrae . . .	4	.70	116.65	P.	H.	
1145	" "	5.4	" . . .	4	.60	116.75	S.	H.	
1146	" "	5.4	" . . .	4	.50	206.60	P.	H.	
1147	" "	5.5	" . . .	4	.55	206.65	S.	H.	
1148	" "	5.7	52 Cygni . . .	4	5.92	205.52	P.	H.	
1149	" "	5.7	" . . .	4	6.57	205.27	S.	H.	
1150	" "	5.8	" . . .	4	5.50	115.60	P.	H.	
1151	" "	5.8	" . . .	4	5.72	115.37	S.	H.	Left eye.
1152	" "	5.9	β Delphini . . .	4	1.97	116.67	P.	H.	
1153	" "	6.0	" . . .	4	2.02	116.57	S.	H.	
1154	" "	6.1	" . . .	4	2.10	206.30	P.	H.	
1155	" "	6.2	" . . .	4	2.32	206.27	S.	H.	
1156	" "	6.3	δ Equulei . . .	4	3.40	206.75	P.	H.	
1157	" "	6.3	" . . .	4	3.67	206.52	S.	H.	Left eye.
1158	" "	6.4	" . . .	4	4.60	116.60	P.	H.	
1159	" "	6.5	" . . .	4	4.40	116.40	S.	H.	Left eye.
1160	" "	6.5	1 Pegasi . . .	4	5.80	116.95	S.	H.	
1161	" "	6.6	" . . .	4	5.35	206.95	S.	H.	
1162	" "	6.8	κ Pegasi . . .	4	4.27	205.97	P.	H.	
1163	" "	6.9	" . . .	4	4.12	206.47	S.	H.	
1164	" "	7.0	" . . .	4	4.07	116.37	P.	H.	
1165	" "	7.0	" . . .	4	3.87	115.92	S.	H.	
1166	" "	7.1	1 Pegasi . . .	4	5.62	115.77	P.	H.	
1167	" "	7.2	" . . .	4	5.45	206.55	P.	H.	
1168	" "	8.7	ξ Cephei . . .	4	20.22	116.62	P.	H.	
1169	" "	8.7	" . . .	4	21.70	114.70	S.	H.	
1170	" "	8.8	" . . .	4	19.97	206.37	P.	H.	
1171	" "	8.8	" . . .	4	22.87	205.77	S.	H.	
1172	" "	9.3	δ Cephei . . .	4	17.12	206.57	P.	H.	
1173	" "	9.3	" . . .	4	20.45	205.95	S.	H.	
1174	" "	9.4	" . . .	4	17.97	117.27	P.	H.	
1175	" "	9.5	" . . .	4	17.45	115.90	S.	H.	
1176	" "	9.9	κ Cephei . . .	4	10.80	206.10	P.	H.	
1177	" "	9.9	" . . .	4	10.47	206.72	S.	H.	
1178	" "	10.0	" . . .	4	9.20	115.40	P.	H.	
1179	" "	10.1	" . . .	4	10.17	116.47	S.	H.	
1180	Dec. 28	5.4	α Lyrae . . .	4	.60	116.70	P.	H.	
1181	" "	5.4	" . . .	4	.72	116.57	S.	H.	
1182	" "	5.5	" . . .	6	.50	206.64	P.	H.	
1183	" "	5.6	" . . .	6	.50	206.86	S.	H.	
1184	" "	5.8	52 Cygni . . .	4	6.25	205.75	P.	H.	
1185	" "	5.8	" . . .	4	6.72	206.47	S.	H.	
1186	" "	5.9	" . . .	4	6.40	116.55	P.	H.	
1187	" "	6.0	" . . .	4	5.45	115.85	S.	H.	
1188	" "	6.2	κ Pegasi . . .	4	4.00	116.05	P.	H.	
1189	" "	6.2	" . . .	4	3.77	116.57	S.	H.	Left eye.
1190	" "	6.4	" . . .	4	4.45	206.15	P.	H.	
1191	" "	6.4	" . . .	4	4.52	206.87	S.	H.	
1192	" "	6.9	ψ^1 Aquarii . . .	4	6.87	207.07	S.	H.	
1193	" "	7.0	" . . .	4	7.60	117.00	S.	H.	
1194	" "	7.8	" . . .	4	6.95	117.10	P.	H.	
1195	" "	7.9	" . . .	4	6.20	206.80	P.	H.	
1196	" "	8.2	Iapetus . . .	5	1.262		P.	I.	
1197	" "	8.4	Titan . . .	5	2.916		P.	I.	
1198	" "	9.0	δ Andromedæ . .	5	2.380		P.	I.	
1199	" "	9.5	μ Andromedæ . .	5	1.580		P.	I.	
1200	" "	9.7	α Arietis . . .	5	1.624		P.	I.	
Total Number . .				7274					

PHOTOMETRIC OBSERVATIONS.

No. for Reference.	Date, 1877-78.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1201	Dec. 29	5.3	ζ Aquarii . . .	4	41.92	206.37	P.	H.	
1202	" "	5.4	" . . .	4	44.90	206.80	P.	H.	
1203	" "	5.5	" . . .	4	41.68	208.77	S.	H.	
1204	" "	5.6	" . . .	4	41.37	207.57	S.	H.	
1205	" "	5.7	α Pegasi . . .	4	3.67	206.57	P.	H.	
1206	" "	5.7	" . . .	4	3.92	206.67	S.	H.	
1207	" "	5.8	" . . .	4	4.65	117.45	P.	H.	
1208	" "	5.8	" . . .	4	4.20	117.45	S.	H.	
1209	" "	6.1	α Lyrae . . .	4	.67	117.12	P.	H.	
1210	" "	6.1	" . . .	4	.57	117.17	S.	H.	Left eye.
1211	" "	6.2	" . . .	4	.57	207.27	P.	H.	
1212	" "	6.2	" . . .	4	.52	207.32	S.	H.	
1213	" "	9.5	α Andromedæ . .	5	2.122		P.	I.	
1214	" "	9.6	" . . .	5	1.844		S.	I.	
1215	Dec. 31	6.5	μ Cygni c . . .	5	1.988		P.	I.	
1216	" "	6.6	" c . . .	1	1.45		S.	I.	Seeing very bad.
1217	Jan. 1	6.9	19 H. Camelopardali	4	10.37	116.37	P.	H.	
1218	" "	8.0	α Ursæ Minoris .	4	2.50	116.45	P.	H.	
1219	" "	8.3	" " . . .	4	2.57	117.12	S.	H.	
1220	" "	8.4	" " . . .	4	2.60	207.25	P.	H.	
1221	" "	8.5	" " . . .	4	2.85	207.30	S.	H.	
1222	" "	8.8	32 H. Camelopardali	4	39.92	208.33	P.	H.	
1223	" "	9.1	" " . . .	4	38.05	205.95	P.	H.	
1224	Jan. 3	5.3	α Lyrae . . .	5	1.072		P.	I.	
1225	" "	5.5	α Aquilæ . . .	5	1.370		P.	I.	
1226	" "	5.6	γ Aquilæ B, α Aquil.	5	.940		P.	I.	
1227	" "	5.7	" " . . .	5	.664		S.	I.	
1228	" "	5.9	β Delphini B . .	5	2.534		P.	I.	
1229	" "	5.9	" c . . .	3	1.803		P.	I.	
1230	" "	6.0	" B . . .	5	1.608		S.	I.	
1231	" "	6.2	α Cygni B . . .	5	.916		P.	I.	A 2d companion seen.
1232	" "	6.3	" B . . .	6	.795		S.	I.	Light through prism troublesome.
1233	" "	6.5	" B . . .	5	.830		P.	I.	Perhaps C.
1234	" "	6.6	" B . . .	5	.692		S.	I.	Perhaps C. Less light through prism.
1235	" "	6.8	σ^2 Cygni . . .	5	2.376		P.	I.	
1236	" "	6.9	" . . .	5	2.098		S.	I.	
1237	" "	8.4	α Andromedæ . .	5	2.140		P.	I.	
1238	" "	8.5	" . . .	5	1.802		S.	I.	
1239	" "	8.9	" . . .	4	1.30	124.25	P.	H.	
1240	" "	8.9	" . . .	4	2.27	124.67	S.	H.	Reflection, not companion.
1241	" "	9.0	" . . .	4	1.22	214.23	P.	H.	
1242	" "	9.2	" . . .	4	1.10	214.30	S.	H.	
1243	" "	9.3	" . . .	4	1.27	124.27	S.	H.	
1244	" "	9.4	μ Andromedæ . .	5	1.528		P.	I.	
1245	" "	9.5	" . . .	4	1.202		S.	I.	Not quite full aperture.
1246	" "	9.7	" . . .	4	1.360		S.	I.	
1247	" "	9.9	α Cassiopeiæ . .	4	2.87	124.12	P.	H.	
1248	" "	10.0	" . . .	4	2.65	213.75	P.	H.	Thermometer 13°.
1249	Jan. 5	5.8	α Lyrae . . .	5	1.038		P.	I.	Seeing bad.
1250	" "	5.9	" . . .	5	.774		S.	I.	
1251	" "	6.0	ε Lyrae E, α Lyrae .	5	1.088		P.	I.	
1252	" "	6.0	" F " . . .	5	.350		P.	I.	
1253	" "	6.1	" G " . . .	5	.370		P.	I.	
1254	" "	6.1	" E " . . .	5	.620		S.	I.	
1255	" "	6.2	" F " . . .	5	.266		S.	I.	
1256	" "	6.3	" G " . . .	5	.288		S.	I.	
1257	" "	6.5	α Delphini B . .	5	2.318		P.	I.	
1258	" "	6.6	" B . . .	5	2.258		S.	I.	
1259	" "	6.7	Iapetus . . .	5	.926		P.	I.	
1260	" "	6.8	" . . .	5	.784		S.	I.	
Total Number . .				7541					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1261	Jan. 5	8.4	β Pegasi	5	1.164		P.	I.	
1262	" "	8.5	"	5	1.074		S.	I.	
1263	" "	8.6	α Andromedæ . .	5	2.144		P.	I.	
1264	" "	8.7	"	5	1.572		S.	I.	
1265	" "	8.9	"	4	1.20	124.15	S.	H.	
1266	" "	9.0	"	4	1.25	214.65	S.	H.	
1267	" "	9.1	"	4	1.15	214.35	P.	H.	
1268	" "	9.2	"	4	1.17	124.48	P.	H.	
1269	" "	9.3	α Ceti	4	5.40	214.15	P.	H.	
1270	" "	9.4	"	4	5.60	124.25	P.	H.	
1271	" "	9.5	γ Ceti	4	14.35	122.75	P.	H.	Images not quite symmetrical.
1272	" "	9.6	"	4	19.27	123.07	P.	H.	
1273	" "	9.7	ν Ceti	2	7.70	34.40	P.	H.	Clock-weight fell.
1274	Jan. 6	5.5	α Aquilæ	5	1.820		P.	I.	
1275	" "	5.6	γ Aquilæ B . . .	5	2.428		P.	I.	
1276	" "	5.8	α Delphini B . .	5	2.700		P.	I.	
1277	" "	5.9	" B	5	2.134		S.	I.	
1278	" "	6.0	β Aquarii B . . .	5	2.456		P.	I.	
1279	" "	6.1	" B	3	2.270		S.	I.	Passing clouds.
1280	" "	6.4	γ Ceti	4	14.55	123.35	P.	H.	A blue.
1281	" "	6.5	"	4	14.87	124.42	S.	H.	
1282	Jan. 9	6.5	ϵ Draconis . . .	4	12.75	213.35	S.	H.	
1283	" "	6.6	"	4	16.72	124.67	S.	H.	Clouds.
1284	Jan. 12	1.2	Artificial Star . .	5	3.674		S.	[I.]	For const. Nos. 1284-1291 have readings alternately decreasing and increasing (even numbers decreasing). Stray light excluded by cap after No. 1285.
1285	" "	1.2	" "	5	3.708		S.	[I.]	
1286	" "	1.8	" "	5	2.764		P.	[I.]	
1287	" "	1.8	" "	5	2.740		P.	[I.]	
1288	" "	1.9	" "	5	3.080		S.	[I.]	
1289	" "	1.9	" "	5	3.082		S.	[I.]	
1290	" "	2.4	" "	5	3.348		P.	[I.]	
1291	" "	2.4	" "	5	2.994		P.	[I.]	
1292	" "	5.3	Sky	5	1.978		P.	I.	} For constant. Aperture 12.7 cms.
1293	" "	5.3	"	5	1.928		P.	I.	
1294	" "	5.5	"	5	5.206		P.	I.	
1295	" "	5.6	α Aquilæ	5	.906		S.	I.	
1296	" "	5.8	β Delphini B . .	5	2.502		P.	I.	C not measurable.
1297	" "	5.9	" B	5	2.148		S.	I.	
1298	" "	6.1	α Aquarii	5	1.744		P.	I.	
1299	" "	6.2	"	5	1.978		S.	I.	
1300	" "	6.3	γ Aquarii	5	2.176		S.	I.	
1301	" "	6.8	Iapetus	5	.846		S.	I.	
1302	" "	6.9	Star near Saturn .	5	.420		S.	I.	
1303	" "	8.3	β Pegasi	5	1.072		P.	I.	
1304	" "	8.4	"	5	1.068		S.	I.	Left eye.
1305	" "	8.6	γ Pegasi B . . .	5	1.558		P.	I.	
1306	" "	8.6	" C	5	1.206		P.	I.	
1307	" "	8.7	" B	5	1.144		S.	I.	
1308	" "	8.8	" C	5	.790		S.	I.	
1309	" "	9.0	δ Andromedæ C .	5	1.888		P.	I.	
1310	" "	9.0	" B	5	2.420		P.	I.	
1311	" "	9.1	" B	5	1.576		S.	I.	
1312	" "	9.3	μ Andromedæ . .	5	1.476		P.	I.	
1313	" "	9.5	β Andromedæ B .	5	1.370		P.	I.	
1314	" "	9.6	" C	5	1.120		P.	I.	
1315	" "	9.6	" D	5	1.112		P.	I.	
1316	" "	9.7	" E	5	1.368		P.	I.	
1317	" "	9.7	" F	5	.904		P.	I.	
1318	" "	9.8	" G	5	1.288		P.	I.	
1319	Jan. 13	5.8	26 Cygni	4	9.47	127.12	P.	H.	
1320	" "	5.9	"	4	9.40	216.55	P.	H.	
Total Number . .				7822					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1321	Jan. 13	6.1	ϵ Draconis . . .	4	12.37	126.47	P.	H.	Clouds.
1322	" "	6.2	" . . .	4	14.40	215.40	P.	H.	
1323	" "	6.4	α Ursæ Minoris . .	4	3.00	126.85	P.	H.	
1324	" "	6.4	" " . . .	4	3.05	126.65	S.	H.	
1325	" "	6.5	" " . . .	4	2.72	216.62	P.	H.	
1326	" "	6.6	" " . . .	5	2.79	216.99	S.	H.	
1327	" "	7.2	π Andromedæ . .	4	8.12	216.67	P.	H.	
1328	" "	7.2	" " . . .	4	8.42	126.82	P.	H.	
1329	" "	22.0	Artificial Star . .	5	2.854		P.	[I.]	
1330	" "	22.0	" " . . .	5	2.662		P.	[I.]	For const. Nos. 1329-1336 have readings alternately decreasing and increasing (odd numbers decreasing).
1331	" "	22.2	" " . . .	5	3.126		S.	[I.]	
1332	" "	22.2	" " . . .	5	3.052		S.	[I.]	
1333	Jan. 14	1.4	" " . . .	5	3.776		P.	[I.]	
1334	" "	1.4	" " . . .	5	3.458		P.	[I.]	
1335	" "	1.7	" " . . .	5	3.478		S.	[I.]	
1336	" "	1.7	" " . . .	5	3.442		S.	[I.]	
1337	" "	6.0	β Delphini c . .	5	2.258		P.	I.	
1338	" "	6.1	" " B . . .	5	3.094		P.	I.	
1339	" "	6.4	ϵ Pegasi c . . .	5	1.450		P.	I.	Dew on object-glass. For constant. Readings alternately decreasing and increasing; odd numbers increasing. Last two sets with left eye.
1340	" "	6.6	γ Aquarii . . .	5	2.008		P.	I.	
1341	" "	6.8	Iapetus . . .	5	.422		S.	I.	
1342	" "	22.4	Artificial Star . .	5	3.592		P.	[I.]	
1343	" "	22.4	" " . . .	5	3.964		P.	[I.]	
1344	" "	23.4	" " . . .	5	3.710		P.	[I.]	
1345	" "	23.4	" " . . .	5	3.448		P.	[I.]	
1346	" "	23.5	" " . . .	5	4.224		S.	[I.]	
1347	" "	23.5	" " . . .	5	4.196		S.	[I.]	
1348	Jan. 16	5.7	β Aquarii B . . .	5	2.478		P.	I.	C not seen.
1349	" "	5.7	" " B . . .	5	2.806		S.	I.	
1350	" "	5.9	γ Aquarii . . .	5	2.486		P.	I.	
1351	" "	6.0	" " . . .	5	2.054		S.	I.	
1352	" "	6.2	Iapetus . . .	5	.542		S.	I.	
1353	" "	6.4	" " . . .	5	.730		P.	I.	
1354	" "	6.5	ζ Pegasi . . .	5	1.974		P.	I.	
1355	" "	6.7	" " . . .	5	1.446		S.	I.	
1356	" "	6.9	ξ Pegasi c . . .	5	3.094		P.	I.	
1357	" "	6.9	" " B . . .	5	2.168		P.	I.	
1358	" "	8.0	α Andromedæ . .	4	1.40	217.15	P.	H.	
1359	" "	8.1	" " . . .	4	1.35	127.15	P.	H.	
1360	" "	8.4	θ Ceti . . .	4	5.85	217.90	P.	H.	
1361	" "	8.5	" " . . .	4	5.12	125.97	P.	H.	
1362	" "	8.7	ν Ceti . . .	4	6.57	126.52	P.	H.	
1363	" "	8.8	" " . . .	4	6.97	216.07	P.	H.	
1364	" "	9.1	λ Arietis . . .	4	16.95	215.80	P.	H.	
1365	" "	9.2	" " . . .	4	17.40	127.00	P.	H.	
1366	" "	9.2	" " . . .	4	16.72	127.57	S.	H.	
1367	" "	9.3	" " . . .	4	15.62	216.82	S.	H.	
1368	" "	9.4	φ Piscium . . .	4	5.77	126.72	P.	H.	
1369	" "	9.6	π Andromedæ . .	4	8.40	127.05	P.	H.	
1370	" "	9.6	" " . . .	4	8.07	127.22	S.	H.	
1371	" "	9.7	" " . . .	4	7.87	216.82	P.	H.	
1372	" "	9.7	" " . . .	4	8.15	217.10	S.	H.	
1373	Jan. 18	6.3	γ Aquarii . . .	5	2.724		P.	I.	
1374	" "	6.4	" " . . .	5	2.354		S.	I.	
1375	" "	6.6	α Piscium . . .	4	34.97	215.42	P.	H.	
1376	" "	6.7	" " . . .	4	36.10	217.60	S.	H.	
1377	" "	6.8	" " . . .	4	33.80	127.15	P.	H.	
1378	" "	6.9	" " . . .	4	35.30	128.05	S.	H.	
1379	" "	7.6	θ Ceti . . .	4	5.47	216.67	P.	H.	
1380	" "	7.7	" " . . .	4	6.12	126.42	P.	H.	
Total Number . .				8094					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1381	Jan. 18	7.8	γ Ceti	4	17.72	126.17	P.	H.	Images arr'd in square.
1382	" "	7.9	"	4	18.00	125.00	P.	H.	{ Diagonals observed alternately.
1383	" "	7.9	"	4	18.80	215.60	P.	H.	
1384	" "	8.1	"	4	14.20	123.60	S.	H.	{ Diagonals observed alternately.
1385	" "	8.1	"	4	20.70	214.10	S.	H.	
1386	" "	8.4	ψ^1 Piscium	4	42.07	214.02	S.	H.	{ Diagonals observed alternately.
1387	" "	8.5	"	4	44.42	216.37	S.	H.	
1388	" "	8.7	"	4	40.77	215.97	P.	H.	
1389	" "	8.7	"	4	42.27	214.67	P.	H.	
1390	" "	9.0	γ Ceti	4	19.97	214.27	M.	H.	{ Diagonals obs. altern. by C. H. Metcalf.
1391	" "	9.0	"	4	20.62	123.57	M.	H.	
1392	" "	9.3	"	4	18.37	124.67	P.	H.	{ Diagonals observed alternately.
1393	" "	9.3	"	4	21.97	214.67	P.	H.	
1394	" "	9.5	λ Arietis	4	17.65	126.10	P.	H.	{ For constant. Readings of 1398 and 1400 decreasing; others increasing. Aperture 12.7 cms.
1395	" "	9.5	"	4	17.82	216.82	P.	H.	
1396	" "	9.6	ι Trianguli	4	23.65	214.25	P.	H.	
1397	" "	9.7	"	4	27.25	126.65	P.	H.	
1398	Jan. 19	5.3	Sky	5	1.970		P.	I.	{ For constant. Readings of 1398 and 1400 decreasing; others increasing. Aperture 12.7 cms.
1399	" "	5.3	"	5	1.908		P.	I.	
1400	" "	5.7	"	5	1.996		S.	I.	
1401	" "	5.7	"	5	1.868		S.	I.	
1402	" "	5.8	ω Fornacis	4	16.05	125.95	P.	H.	
1403	" "	5.9	"	4	16.37	125.37	S.	H.	
1404	" "	5.9	"	4	15.52	216.57	S.	H.	
1405	" "	6.0	"	4	15.55	215.50	P.	H.	
1406	" "	6.4	ξ Pegasi c	5	2.806		P.	I.	
1407	" "	6.5	" B	5	2.066		P.	I.	
1408	" "	6.5	" B	5	1.996		S.	I.	
1409	" "	6.6	" C	5	2.482		S.	I.	
1410	" "	6.9	ζ Pegasi	5	1.250		S.	I.	
1411	" "	7.0	"	5	1.866		P.	I.	
1412	" "	7.7	f Eridani	4	33.37	214.32	P.	H.	
1413	" "	7.8	"	4	39.80	215.05	P.	H.	
1414	" "	8.1	"	4	37.70	214.70	S.	H.	
1415	" "	8.2	"	4	36.72	215.72	S.	H.	
1416	" "	8.4	γ Ceti	4	18.60	124.45	P.	H.	{ Diag. obs. alt.; images not quite close enough.
1417	" "	8.4	"	4	16.85	214.95	P.	H.	
1418	" "	8.5	"	4	17.42	124.87	S.	H.	{ Closer, perhaps too close. Diag. obs. alt.
1419	" "	8.5	"	4	23.05	215.75	S.	H.	
1420	" "	8.8	γ Ceti B, B	4	44.55	215.75	P.	H.	{ Two images of component B.
1421	" "	8.8	" B, B	4	42.55	216.35	P.	H.	
1422	" "	8.9	" A, A	4	44.62	217.22	P.	H.	{ Two images of component A.
1423	" "	8.9	" A, A	4	47.80	215.60	P.	H.	
1424	" "	9.0	" B, B	4	46.87	217.67	S.	H.	{ Two images of component B.
1425	" "	9.1	" B, B	4	45.77	214.42	S.	H.	
1426	" "	9.1	" A, A	4	43.55	214.80	S.	H.	{ Two images of component A.
1427	" "	9.2	" A, A	4	42.20	214.05	S.	H.	
1428	" "	9.3	ν Ceti	4	7.57	125.82	P.	H.	{ Stars in line. A out of field. Barely visible, clouds.
1429	" "	9.4	"	4	7.62	216.12	P.	H.	
1430	" "	9.5	π Andromedæ	4	7.20	216.25	P.	H.	
1431	" "	9.5	"	4	8.00	216.25	S.	H.	
1432	" "	9.6	"	4	7.92	126.82	S.	H.	{ Stars in line. A out of field. Barely visible, clouds.
1433	" "	9.7	"	4	8.17	126.47	P.	H.	
1434	" "	9.8	ι Trianguli	4	26.75	126.10	S.	H.	
1435	" "	9.8	"	4	28.25	127.20	P.	H.	
1436	" "	9.8	"	4	26.90	216.60	S.	H.	{ Stars in line. A out of field. Barely visible, clouds.
1437	" "	9.9	"	4	30.32	216.37	P.	H.	
1438	Jan. 22	6.4	α Cassiopeiæ	4	2.70	126.50	S.	H.	
1439	" "	6.5	"	4	2.25	216.85	S.	H.	
1440	Jan. 24	6.2	α Piscium	4	33.52	215.22	P.	H.	
Total Number				8344					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1441	Jan. 24	6.2	α Piscium . . .	4	33.27	217.52	S.	H.	Clouds.
1442	" "	6.3	" . . .	4	34.80	214.20	P.	H.	
1443	" "	6.4	" . . .	4	31.35	126.85	S.	H.	
1444	" "	7.2	η Cassiopeiæ . .	4	10.12	216.32	P.	H.	
1445	" "	7.3	" . . .	4	10.12	125.97	P.	H.	
1446	" "	7.4	α Cassiopeiæ . .	4	2.52	216.92	P.	H.	A blue, B yellow.
1447	" "	7.4	" . . .	4	2.72	126.82	P.	H.	
1448	" "	7.5	ι Cassiopeiæ Δ , B .	4	20.90	124.90	P.	H.	[distant.
1449	" "	7.6	" Δ , B .	4	20.15	216.70	P.	H.	Images somewhat too
1450	" "	8.3	" Δ , B .	4	21.97	217.02	S.	H.	Stars faint and blurred.
1451	" "	8.5	" Δ , B .	4	20.92	124.27	S.	H.	
1452	" "	8.9	" Δ , C .	4	12.55	216.55	S.	H.	Seeing better.
1453	" "	9.0	" Δ , C .	4	13.30	125.35	S.	H.	
1454	" "	9.3	η Cassiopeiæ . .	4	10.80	126.15	S.	H.	Seeing worse. Left eye.
1455	" "	9.4	" . . .	4	10.17	216.07	S.	H.	Left eye.
1456	" "	9.5	α Cassiopeiæ . .	4	2.82	126.97	S.	H.	{ A out of field.
1457	" "	9.6	" . . .	4	3.12	216.87	S.	H.	
1458	" "	9.9	ψ Cassiopeiæ Δ , BC	4	8.32	126.22	S.	H.	[distance.
1459	" "	10.0	" Δ , BC	4	4.70	126.50	S.	H.	Reversed images; altered
1460	" "	10.1	" Δ , BC	4	5.20	216.90	S.	H.	Jan. 24. Seeing generally bad.
1461	Jan. 25	5.9	55 Piscium . . .	4	12.87	216.07	P.	H.	
1462	" "	5.9	" . . .	4	12.65	216.20	S.	H.	
1463	" "	5.9	" . . .	4	13.90	126.00	P.	H.	A bluer than B.
1464	" "	6.0	" . . .	4	12.20	126.30	S.	H.	
1465	" "	6.2	φ Piscium . . .	4	6.20	125.50	S.	H.	
1466	" "	6.3	" . . .	4	6.22	125.57	P.	H.	
1467	" "	6.3	" . . .	4	5.45	215.75	S.	H.	
1468	" "	6.4	" . . .	4	5.85	215.95	P.	H.	
1469	" "	6.8	γ Ceti . . .	4	19.72	124.92	P.	H.	{ Images at 45°.
1470	" "	6.9	" . . .	4	15.80	126.65	U.	H.	
1471	" "	7.1	" . . .	4	18.95	215.85	U.	H.	Images at 45°, too close.
1472	" "	7.2	" . . .	4	20.67	216.02	P.	H.	Images at 45°.
1473	" "	7.4	" . . .	4	18.27	124.87	P.	H.	{ Images at 90°. Diagonals observed alternately.
1474	" "	7.4	" . . .	4	15.35	214.30	P.	H.	
1475	" "	7.5	" . . .	4	14.07	127.32	U.	H.	
1476	" "	7.5	" . . .	4	17.20	217.70	U.	H.	
1477	" "	7.8	ν Ceti . . .	4	6.17	125.52	P.	H.	
1478	" "	8.0	" . . .	4	8.20	215.60	P.	H.	
1479	" "	8.6	Mars, R 3 . . .	5	2.168		P.	I.	{ For constant. Aperture 12.7 cms.
1480	" "	9.0	" R 3 . . .	5	2.520		S.	I.	
1481	" "	9.4	" R 3 . . .	6	2.113		P.	I.	
1482	" "	9.8	γ Andromedæ . .	4	15.22	215.37	S.	H.	A yellow, B bluish-white.
1483	" "	9.8	" . . .	4	14.20	216.10	P.	H.	
1484	" "	9.9	" . . .	4	15.25	125.15	S.	H.	
1485	" "	9.9	" . . .	4	14.75	125.65	P.	H.	B blue, not green.
1486	Jan. 26	5.3	Zero . . .	5		36.60	P.	[H.]	Zero in various parts of field.
1487	" "	5.3	" . . .	5		216.84	P.	[H.]	
1488	" "	5.4	" . . .	13			P.	[H.]	
1489	" "	5.5	Reflected image .	4	1.60	126.65	P.	[H.]	
1490	" "	5.5	" " .	4	1.97	216.67	P.	[H.]	
1491	" "	5.6	" " .	4	1.75	126.65	P.	[H.]	
1492	" "	5.6	" " .	4	1.90	216.75	P.	[H.]	
1493	" "	5.7	Zero . . .	13			P.	[H.]	{ Dew on object-glass.
1494	" "	6.2	η Cassiopeiæ . .	4	10.07	126.12	P.	H.	
1495	" "	6.3	" . . .	4	10.00	216.15	P.	H.	
1496	" "	7.7	δ Andromedæ . .	5	1.430		P.	I.	{ Artificial satellite.
1497	Jan. 28	6.0	Venus . . .	17			P.	I.	
1498	" "	6.4	" . . .	4			S.	I.	
1499	" "	7.4	23 Orionis . . .	4	18.67	115.77	U.	H.	Seeing very bad.
1500	" "	7.5	" . . .	4	19.32	114.17	P.	H.	
Total Number . .				8622					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1501	Jan. 28	7.6	23 Orionis . . .	4	19.75	205.60	P.	H.	
1502	" "	7.6	" . . .	4	21.07	206.42	U.	H.	
1503	" "	7.7	δ Orionis . . .	4	12.67	205.57	U.	H.	Images too distant.
1504	" "	7.8	" . . .	4	10.90	115.90	U.	H.	Possibly in dark edge of field.
1505	" "	7.8	" . . .	4	7.20	115.70	P.	H.	
1506	" "	7.9	" . . .	4	7.12	206.02	P.	H.	
1507	" "	7.9	" . . .	4	7.52	205.67	U.	H.	
1508	" "	8.0	" . . .	4	7.95	116.15	U.	H.	
1509	" "	8.1	ι Orionis . . .	4	6.62	205.35	P.	H.	
1510	" "	8.3	" . . .	4	6.22	159.77	S.	H.	
1511	" "	8.3	" . . .	4	8.62	204.57	P.	H.	
1512	" "	8.4	" . . .	4	7.17	115.32	S.	H.	
1513	" "	8.5	θ^2 Orionis . . .	4	25.65	115.50	P.	H.	[ered.]
1514	" "	8.6	" . . .	4	25.00	203.85	S.	H.	Object-glass partly cov-
1515	" "	8.7	" . . .	4	27.97	218.02	P.	H.	Index slipped.
1516	" "	8.7	" . . .	4	27.22	221.37	S.	H.	
1517	" "	8.9	8 Monocerotis . .	4	23.10	222.40	S.	H.	
1518	" "	9.0	" . . .	4	21.97	221.27	U.	H.	
1519	" "	9.1	" . . .	4	20.72	132.17	S.	H.	
1520	" "	9.1	" . . .	4	20.95	131.85	U.	H.	
1521	" "	9.4	11 Monocerotis A, BC	4	45.67	221.87	S.	H.	B and C apparently not separated.
1522	" "	9.5	" A, BC	4	42.90	222.90	U.	H.	
1523	" "	9.6	" A, BC	4	47.28	221.32	S.	H.	
1524	" "	9.7	" A, BC	4	43.80	222.90	U.	H.	
1525	Jan. 29	5.9	ω Fornacis . . .	4	14.00	174.35	P.	H.	
1526	" "	6.0	" . . .	4	14.50	174.20	S.	H.	
1527	" "	6.0	" . . .	4	15.62	174.17	P.	H.	
1528	" "	6.1	" . . .	4	16.40	174.15	S.	H.	
1529	" "	6.4	ι Ceti . . .	5	3.472		P.	I.	Seeing good.
1530	" "	6.7	" . . .	5	4.996		S.	I.	Wrong star.
1531	" "	6.9	" . . .	5	4.020		U.	I.	
1532	" "	7.1	" . . .	5	2.908		S.	I.	
1533	" "	7.6	γ Pegasi B . . .	5	1.930		P.	I.	{ Alternate settings on B and C.
1534	" "	7.6	" C . . .	5	1.292		P.	I.	
1535	" "	7.8	" B . . .	5	1.418		U.	I.	
1536	" "	7.9	" C . . .	5	.942		U.	I.	
1537	" "	8.1	θ Ceti . . .	5	1.274		P.	I.	Seeing unusually good.
1538	" "	8.8	" . . .	5	1.370		U.	I.	
1539	" "	9.0	Star . . .	4	33.52	187.62	S.	H.	{ Photom. H, on comet-seeker; constant for achromatic prisms.
1540	" "	9.4	" . . .	8	29.76	178.66	U.	H.	
1541	" "	9.4	δ Andromedæ c .	5	2.202		P.	I.	
1542	" "	9.5	" B . . .	5	3.134		P.	I.	
1543	" "	9.6	" B . . .	5	2.090		S.	I.	
1544	Jan. 30	5.9	ω Fornacis . . .	4	16.87	223.37	P.	H.	
1545	" "	6.0	" . . .	4	15.77	133.57	S.	H.	
1546	" "	6.5	ε Cygni B . . .	5	1.548		P.	I.	
1547	" "	6.5	" C . . .	5	1.216		P.	I.	
1548	" "	6.9	" B . . .	5	1.848		S.	I.	
1549	" "	7.7	Zero . . .	4			P.	[H.]	
1550	" "	7.9	ψ Cassiopeiae . .	4	7.25	223.75	P.	H.	
1551	" "	8.0	" . . .	4	4.70	223.20	U.	H.	Very faint, hazy.
1552	" "	8.1	" . . .	4	4.55	133.40	U.	H.	
1553	" "	8.1	" . . .	4	7.65	132.45	P.	H.	
1554	" "	8.2	" . . .	4	9.05	132.65	S.	H.	
1555	" "	8.3	" . . .	4	6.42	222.02	S.	H.	
1556	" "	8.5	ι Cassiopeiae A, C .	4	11.25	224.25	P.	H.	Haze.
1557	Feb. 2	6.6	θ Eridani . . .	4	31.40	135.45	P.	H.	Images strongly colored
1558	" "	8.4	θ^1 Orionis A, B . .	4	26.37	223.62	S.	H.	
1559	" "	8.5	" A, C . . .	4	26.10	222.35	S.	H.	
1560	" "	8.6	Zero . . .	5		— .16	P.	I.	
Total Number . .				8883					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1561	Feb. 2	8.6	θ^1 Orionis A, D . .	4	16.35	223.55	S.	H.	
1562	" "	8.7	" B, C . .	4	45.05	198.25	S.	H.	
1563	" "	8.8	" B, D . .	4	34.67	223.52	S.	H.	
1564	" "	8.9	" C, D . .	4	28.22	223.52	S.	H.	
1565	" "	9.0	" A, B . .	4	24.40	224.90	P.	H.	
1566	" "	9.0	" A, C . .	4	24.27	223.42	P.	H.	
1567	" "	9.1	" A, D . .	4	15.65	223.80	P.	H.	
1568	" "	9.1	" B, C . .	4	44.17	223.27	P.	H.	
1569	" "	9.2	" B, D . .	4	32.12	224.17	P.	H.	
1570	" "	9.2	" C, D . .	4	30.25	222.15	P.	H.	
1571	" "	9.5	σ Orionis A, D . .	4	4.70	223.85	P.	H.	
1572	" "	9.6	" A, D . .	4	5.22	134.57	P.	H.	
1573	" "	9.6	" A, C . .	4	14.40	223.80	P.	H.	
1574	" "	9.6	" A, C . .	4	13.70	133.65	P.	H.	
1575	" "	9.7	" A, B . .	4	14.50	133.05	P.	H.	
1576	" "	9.7	" A, B . .	4	16.35	222.05	P.	H.	
1577	" "	9.7	" A, B . .	4	16.20	222.15	S.	H.	
1578	" "	9.8	" A, B . .	4	14.07	132.47	S.	H.	
1579	" "	9.9	" A, C . .	4	14.87	133.17	S.	H.	
1580	" "	10.0	" A, C . .	4	15.55	223.40	S.	H.	
1581	" "	10.0	" A, D . .	4	4.75	223.85	S.	H.	
1582	" "	10.1	" A, D . .	4	4.35	134.10	S.	H.	
1583	Feb. 3	6.7	θ Eridani . . .	4	30.00	169.80	P.	H.	
1584	" "	6.7	" . . .	4	32.47	170.77	S.	H.	
1585	" "	6.8	" . . .	4	33.57	168.62	P.	H.	
1586	" "	6.8	" . . .	4	29.62	170.72	S.	H.	
1587	" "	6.9	f Eridani . . .	4	38.97	168.27	P.	H.	
1588	" "	6.9	" . . .	4	35.12	168.62	S.	H.	
1589	" "	6.9	" . . .	4	38.87	168.57	P.	H.	
1590	" "	7.0	" . . .	4	35.40	169.30	S.	H.	
1591	" "	7.7	39 Eridani . . .	4	8.67	169.72	P.	H.	
1592	" "	7.8	" . . .	4	10.77	169.82	P.	H.	
1593	" "	8.0	σ^2 40 Eridani D . .	5	2.658		P.	I.	
1594	" "	8.1	" C . .	5	4.130		P.	I.	
1595	" "	8.2	" D . .	5	2.552		S.	I.	
1596	" "	8.3	" C . .	5	3.784		S.	I.	
1597	" "	8.6	γ Ceti . . .	4	21.72	168.97	P.	H.	{ Diagonals observed alternately.
1598	" "	8.6	" . . .	4	17.70	167.45	P.	H.	
1599	" "	8.7	" . . .	4	18.72	166.57	P.	H.	{ Diagonals observed alternately.
1600	" "	8.7	" . . .	4	19.02	167.82	P.	H.	
1601	" "	8.8	" . . .	4	15.90	165.90	S.	H.	{ Diagonals observed alternately.
1602	" "	8.8	" . . .	4	16.40	167.40	S.	H.	
1603	" "	9.0	" . . .	4	16.92	167.82	S.	H.	{ Diagonals observed alternately.
1604	" "	9.0	" . . .	4	18.12	167.07	S.	H.	
1605	" "	9.3	α Tauri c . . .	5	.654		P.	I.	
1606	" "	9.3	" . . .	5	.470		P.	I.	
1607	" "	9.7	Titania, α Leonis .	5	.470		P.	I.	Limit of visibility.
1608	" "	9.8	Titania, Uranus .	5	3.030		P.	I.	
1609	" "	9.9	Oberon, α Leonis .	5	.554		P.	I.	
1610	" "	10.0	Oberon, Uranus .	5	3.464		P.	I.	
1611	Feb. 4	5.8	θ Eridani . . .	4	29.52	166.82	P.	H.	
1612	" "	5.9	" . . .	4	34.40	169.05	S.	H.	
1613	" "	5.9	" . . .	4	31.80	165.00	P.	H.	
1614	" "	6.0	" . . .	4	28.97	169.07	S.	H.	
1615	" "	6.1	f Eridani . . .	4	37.97	169.42	P.	H.	
1616	" "	6.1	" . . .	4	38.57	167.97	S.	H.	
1617	" "	6.2	" . . .	4	34.75	166.65	P.	H.	
1618	" "	6.3	" . . .	4	36.47	167.87	S.	H.	
1619	" "	6.6	Saturn's Ring . .	5	5.864		S.	I.	{ Saturn reduced to a line by cylindrical lens.
1620	" "	6.9	" " . .	5	5.464		U.	I.	
Total Number . .				9135					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1621	Feb. 4	7.3	μ Cygni c . . .	5	3.350		P.	I.	Faint and low. B reddish, not confirmed by P. and S.
1622	" "	7.3	" c . . .	4	3.518		U.	I.	
1623	" "	7.8	θ Ceti . . .	5	1.132		P.	I.	
1624	" "	7.9	" . . .	5	1.200		U.	I.	
1625	" "	8.7	δ Andromedæ c .	5	2.454		P.	I.	
1626	" "	8.8	" c .	5	2.100		S.	I.	
1627	" "	8.9	" c .	5	2.384		U.	I.	
1628	" "	9.2	Oberon, α Leonis .	5	.538		P.	I.	
1629	" "	9.2	" Uranus .	5	3.326		P.	I.	
1630	" "	9.5	" α Leonis .	5	.434		U.	I.	
1631	" "	9.6	" Uranus .	5	2.374		U.	I.	
1632	" "	9.9	" α Leonis .	5	.442		S.	I.	
1633	" "	10.2	" Uranus .	6	2.447		S.	I.	
1634	Feb. 5	5.9	θ Eridani . . .	4	30.75	138.35	P.	H.	
1635	" "	6.0	" . . .	4	30.50	228.10	P.	H.	
1636	" "	6.7	ι Ceti . . .	5	2.286		P.	I.	Became cloudy. } Stars 3' and 4' n. of γ } compared with γ . A blue, BC yellow. A bluish, BC dusky. } A pale yellow, BC } slightly orange. } For constant. Aper- } ture 12.7 cms.
1637	" "	6.8	" . . .	5	2.866		S.	I.	
1638	" "	7.0	" . . .	5	2.960		U.	I.	
1639	" "	7.3	θ Ceti . . .	5	1.346		P.	I.	
1640	" "	7.4	" . . .	5	1.500		U.	I.	
1641	" "	7.5	γ Pegasi c . . .	5	1.448		P.	I.	
1642	" "	7.5	" B . . .	5	2.022		P.	I.	
1643	" "	7.6	" C . . .	5	.834		U.	I.	
1644	" "	7.7	" B . . .	5	1.240		U.	I.	
1645	" "	7.9	ν Ceti . . .	4	6.15	138.10	U.	H.	
1646	" "	7.9	" . . .	4	6.30	227.70	U.	H.	
1647	" "	8.9	α Canis Majoris D	5	.540		P.	I.	
1648	" "	8.9	" " C	5	.288		P.	I.	
1649	" "	9.0	" " C	5	.260		S.	I.	
1650	" "	9.1	" " D	5	.450		S.	I.	
1651	" "	9.4	" " A, B	10	.71	140.99	P.	H.	
1652	" "	9.7	" " A, B	2	.20	228.10	P.	H.	
1653	Feb. 6	6.4	β Orionis c . . .	5	.630		P.	I.	
1654	" "	6.4	" c . . .	2	.420		S.	I.	
1655	" "	7.0	γ Cassiopeiæ . .	5	.764		S.	I.	
1656	" "	7.0	" . . .	5	.760		S.	I.	
1657	" "	7.1	" . . .	5	.982		S.	I.	
1658	" "	7.2	" . . .	5	.872		U.	I.	
1659	" "	7.3	" . . .	5	.898		P.	I.	
1660	" "	7.3	γ Cephei c . . .	5	1.712		P.	I.	
1661	" "	7.4	" c . . .	5	1.600		U.	I.	
1662	" "	7.9	ψ Cassiopeiæ A, BC	4	9.77	228.92	P.	H.	
1663	" "	8.0	" " A, BC	4	5.85	227.55	U.	H.	
1664	" "	8.1	" " A, BC	4	10.32	140.02	P.	H.	
1665	" "	8.2	" " A, BC	4	8.32	139.47	U.	H.	
1666	" "	8.3	" " A, BC	4	10.25	139.45	S.	H.	
1667	" "	8.4	" " A, BC	4	11.65	228.80	S.	H.	
1668	" "	8.5	α Cassiopeiæ . .	4	3.02	227.21	S.	H.	
1669	" "	8.6	" . . .	4	2.50	137.40	S.	H.	
1670	" "	8.7	" . . .	4	2.82	137.07	U.	H.	
1671	" "	8.8	" . . .	4	2.65	226.80	U.	H.	
1672	Feb. 7	5.7	Sky . . .	5	1.880		P.	I.	
1673	" "	5.8	" . . .	5	1.918		P.	I.	
1674	" "	6.6	ι Ceti . . .	5	2.300		P.	I.	
1675	" "	6.6	" . . .	5	1.812		S.	I.	
1676	" "	6.8	" . . .	5	2.046		U.	I.	
1677	" "	7.3	η Cephei B . . .	5	2.076		P.	I.	
1678	" "	7.3	" c . . .	5	1.258		P.	I.	
1679	" "	7.4	" c . . .	5	1.086		U.	I.	
1680	" "	7.5	" B . . .	5	2.296		U.	I.	
Total Number . .				9420					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1681	Feb. 7	7.8	γ Cephei c . . .	5	1.520		P.	I.	
1682	" "	7.8	" " c . . .	5	1.586		U.	I.	
1683	" "	8.2	γ Cassiopeia . . .	5	1.344		S.	I.	
1684	" "	8.4	" " . . .	5	1.238		U.	I.	
1685	" "	8.4	" " . . .	5	1.336		P.	I.	
1686	" "	8.9	α Tauri B . . .	5	1.060		P.	I.	
1687	" "	8.9	" B . . .	5	1.150		S.	I.	} C not seen.
1688	" "	9.0	" B . . .	5	1.098		U.	I.	
1689	" "	9.6	Titania, α Leonis .	5	.636		P.	I.	
1690	" "	9.6	" Uranus .	5	3.800		P.	I.	
1691	" "	9.7	" " .	5	3.304		U.	I.	
1692	" "	9.8	" α Leonis .	5	.516		U.	I.	
1693	" "	10.0	" " .	5	.534		S.	I.	
1694	" "	10.1	" Uranus .	5	3.002		S.	I.	
1695	" "	10.8	Eva, β Aurigae .	5	.504		U.	I.	
1696	" "	10.9	" " .	5	.616		P.	I.	
1697	" "	11.0	" " .	5	.598		U.	I.	
1698	" "	11.1	" " .	5	.640		P.	I.	
1699	Feb. 11	6.2	32 Eridani . . .	4	26.60	137.00	P.	H.	Feb. 11. Seeing fair at instants, variable, most- ly bad.
1700	" "	6.2	" . . .	4	26.12	136.17	S.	H.	
1701	" "	6.3	" . . .	4	26.85	227.40	P.	H.	
1702	" "	6.3	" . . .	4	27.57	227.92	S.	H.	
1703	" "	6.5	ι Leporis . . .	4	7.00	226.00	P.	H.	
1704	" "	6.6	" . . .	4	6.75	226.70	S.	H.	
1705	" "	6.6	" . . .	4	7.05	136.35	P.	H.	
1706	" "	6.7	" . . .	4	6.77	136.87	S.	H.	
1707	" "	6.8	" . . .	4	5.92	136.82	U.	H.	
1708	" "	6.9	" . . .	4	6.75	226.05	U.	H.	
1709	" "	7.2	σ^2 40 Eridani A, BC	4	4.85	135.05	P.	H.	BC not separated.
1710	" "	7.3	" A, BC	4	4.60	134.50	U.	H.	
1711	" "	7.3	" A, BC	4	4.52	224.37	P.	H.	
1712	" "	7.4	" A, BC	4	5.42	224.57	U.	H.	Images look brighter than before.
1713	" "	7.6	ι Leporis . . .	4	5.77	135.37	P.	H.	
1714	" "	7.6	" . . .	4	5.30	135.30	U.	H.	
1715	" "	7.7	" . . .	4	6.50	225.60	U.	H.	
1716	" "	7.8	" . . .	4	6.35	225.75	P.	H.	
1717	" "	7.9	β Orionis . . .	4	3.40	136.25	U.	H.	
1718	" "	8.0	" . . .	4	3.57	226.37	U.	H.	
1719	" "	8.1	" . . .	4	4.02	225.92	P.	H.	
1720	" "	8.2	" . . .	4	4.02	136.47	P.	H.	
1721	" "	8.6	ρ Orionis . . .	4	9.27	136.12	S.	H.	
1722	" "	8.6	" . . .	4	8.72	226.77	S.	H.	
1723	" "	8.7	" . . .	4	9.00	225.60	U.	H.	
1724	" "	8.8	" . . .	4	9.17	135.57	U.	H.	
1725	" "	8.9	23 Orionis . . .	4	24.02	134.72	U.	H.	} Images in line.
1726	" "	9.0	" . . .	4	25.92	223.72	U.	H.	
1727	" "	9.1	" . . .	4	21.47	224.32	S.	H.	
1728	" "	9.1	" . . .	4	19.55	134.95	S.	H.	} Images in rhombus.
1729	" "	9.2	δ Orionis . . .	4	6.72	134.72	P.	H.	
1730	" "	9.2	" . . .	4	7.22	134.82	S.	H.	
1731	" "	9.3	" . . .	4	6.87	224.52	P.	H.	
1732	" "	9.3	" . . .	4	6.92	224.77	S.	H.	
1733	" "	9.4	θ^2 Orionis . . .	4	28.02	225.62	P.	H.	
1734	" "	9.4	" . . .	4	26.02	224.32	S.	H.	
1735	" "	9.5	" . . .	4	27.17	135.37	P.	H.	
1736	" "	9.5	" . . .	4	25.52	134.57	S.	H.	
1737	" "	9.6	ι Orionis . . .	4	33.85	224.25	P.	H.	Apparently wrong star.
1738	" "	9.6	" . . .	4	30.92	222.72	S.	H.	
1739	" "	9.7	" . . .	4	31.95	133.30	P.	H.	
1740	" "	9.7	" . . .	4	31.80	133.40	S.	H.	
Total Number . .				9678					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1741	Feb. 11	9.8	ι Orionis	4	32.70	133.40	U.	H.	Apparently wrong star.
1742	" "	9.8	"	4	32.15	221.25	U.	H.	
1743	Feb. 13	9.5	ρ Orionis	4	9.12	140.02	S.	H.	Feb. 13. Seeing pretty good, soon bad.
1744	" "	9.5	"	4	9.80	230.35	S.	H.	
1745	" "	9.6	"	4	10.00	229.10	U.	H.	
1746	" "	9.7	"	4	10.37	139.47	U.	H.	
1747	" "	9.8	λ Orionis A, B . .	4	22.12	139.67	S.	H.	Reduced image could not be brought close enough.
1748	" "	9.9	" A, B	4	19.65	229.10	S.	H.	
1749	" "	10.0	" A, B	4	22.90	244.85	U.	H.	
1750	" "	10.0	" A, B	4	22.62	155.47	U.	H.	
1751	Feb. 14	5.9	ρ Orionis	4	8.72	153.77	P.	H.	
1752	" "	5.9	"	4	8.92	154.37	S.	H.	
1753	" "	6.0	"	4	9.92	244.27	P.	H.	
1754	" "	6.1	"	4	9.25	245.15	S.	H.	
1755	" "	6.2	23 Orionis	4	21.72	242.87	P.	H.	
1756	" "	6.3	"	4	20.15	243.35	S.	H.	
1757	" "	6.3	"	4	18.75	152.05	P.	H.	
1758	" "	6.4	"	4	21.05	152.15	S.	H.	
1759	" "	6.5	θ^1 Orionis A, B . .	4	26.70	150.20	P.	H.	
1760	" "	6.5	" A, C	4	25.72	150.27	P.	H.	
1761	" "	6.6	" A, D	4	17.10	151.15	P.	H.	
1762	" "	6.6	" B, C	4	45.95	150.20	P.	H.	
1763	" "	6.6	" B, D	4	32.05	151.40	P.	H.	
1764	" "	6.7	" C, D	4	30.72	149.42	P.	H.	
1765	" "	6.7	" A, B	4	26.77	152.37	S.	H.	
1766	" "	6.8	" A, C	4	28.52	241.32	S.	H.	
1767	" "	6.8	" A, D	4	17.07	242.82	S.	H.	
1768	" "	6.9	" B, C	4	38.42	150.72	S.	H.	
1769	" "	7.0	" B, D	4	33.97	241.67	S.	H.	
1770	" "	7.0	" C, D	4	29.10	152.55	S.	H.	
1771	" "	7.3	β Orionis	4	2.90	240.60	P.	H.	
1772	" "	7.3	"	4	3.05	241.15	U.	H.	
1773	" "	7.4	"	4	3.05	151.50	U.	H.	
1774	" "	7.5	"	4	2.80	151.45	P.	H.	
1775	" "	7.6	θ^1 Orionis A, B . .	4	31.22	150.27	U.	H.	
1776	" "	7.7	" A, C	4	27.70	152.35	U.	H.	
1777	" "	7.8	" A, D	4	19.40	150.90	U.	H.	
1778	" "	7.9	" B, C	4	42.50	150.50	U.	H.	Seeing bad, worse later.
1779	" "	8.0	" B, D	4	33.57	152.52	U.	H.	
1780	" "	8.0	" C, D	4	34.62	154.37	U.	H.	
1781	" "	8.5	θ^2 Orionis	4	26.65	241.60	U.	H.	
1782	" "	8.6	"	4	26.20	150.80	U.	H.	
1783	" "	8.7	σ Orionis A, B . .	4	18.57	147.92	U.	H.	
1784	" "	8.8	" A, B	4	17.87	238.17	U.	H.	
1785	" "	8.9	" A, C	4	14.07	240.92	U.	H.	
1786	" "	8.9	" A, C	4	13.72	151.32	U.	H.	
1787	" "	9.0	" A, D	4	4.07	240.42	U.	H.	
1788	" "	9.0	" A, D	4	6.02	152.77	U.	H.	
1789	" "	9.2	" A, D	4	4.30	151.40	S.	H.	} Distance not altered, but symmetry seems improved in second set.
1790	" "	9.3	" A, D	4	5.52	241.87	S.	H.	
1791	" "	9.4	" A, C	4	16.30	151.30	S.	H.	
1792	" "	9.4	" A, C	4	14.37	241.32	S.	H.	
1793	" "	9.5	" A, B	4	16.47	239.82	S.	H.	
1794	" "	9.5	" A, B	4	16.87	148.97	S.	H.	
1795	" "	10.0	54 Leonis	4	21.42	153.52	S.	H.	
1796	" "	10.0	"	4	21.70	243.70	S.	H.	
1797	" "	10.1	"	4	21.92	242.92	U.	H.	
1798	" "	10.2	"	4	23.62	155.72	U.	H.	
1799	Feb. 15	6.2	θ^1 Orionis A, B . .	4	27.32	154.32	P.	H.	Feb. 15. Thick haze, seeing fair.
1800	" "	6.2	" A, C	4	24.30	242.15	P.	H.	
Total Number . .				9918					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1801	Feb. 15	6.3	θ^1 Orionis A, D . .	4	16.00	242.40	P.	H.	
1802	" "	6.3	" B, C . .	4	43.00	151.90	P.	H.	
1803	" "	6.4	" B, D . .	4	33.67	152.07	P.	H.	
1804	" "	6.5	" C, D . .	4	28.52	152.97	P.	H.	
1805	" "	6.7	λ Orionis A, B . .	4	21.42	152.62	P.	H.	
1806	" "	6.7	" A, B . .	4	23.12	244.22	P.	H.	
1807	" "	6.9	" A, B . .	4	25.52	243.72	U.	H.	
1808	" "	7.0	" A, B . .	4	26.50	153.85	U.	H.	
1809	" "	7.4	δ Orionis	4	7.35	151.85	U.	H.	Barely seen.
1810	" "	7.5	"	4	9.17	242.27	U.	H.	Comp. looks brighter.
1811	" "	7.7	ζ Orionis A, B . .	4	21.80	157.75	U.	H.	Reduced image could not be brought close enough.
1812	" "	7.8	" A, B . .	4	20.30	246.10	U.	H.	
1813	" "	8.1	α Geminorum A, B .	4	33.35	152.85	U.	H.	
1814	" "	8.2	" A, B .	4	31.77	154.27	U.	H.	
1815	" "	8.6	ζ Cancri AB, C . .	4	33.15	157.90	U.	H.	
1816	" "	8.6	" AB, C . .	4	33.47	156.17	U.	H.	
1817	" "	8.7	" AB, C . .	4	33.95	158.10	S.	H.	
1818	" "	8.8	" AB, C . .	4	31.77	153.17	S.	H.	
1819	" "	8.8	" AB, C . .	4	32.55	154.25	P.	H.	
1820	" "	8.9	" AB, C . .	4	34.52	153.92	P.	H.	
1821	" "	9.3	ζ Orionis A, B . .	4	22.22	154.77	P.	H.	
1822	" "	9.4	" A, B . .	4	18.55	156.95	S.	H.	
1823	" "	9.5	" A, B . .	4	22.75	243.75	P.	H.	
1824	" "	9.6	" A, B . .	4	22.60	246.25	S.	H.	
1825	" "	9.7	ι Orionis	4	7.42	249.22	P.	H.	
1826	" "	9.7	"	4	7.37	248.72	U.	H.	
1827	" "	9.8	"	4	6.85	159.40	U.	H.	
1828	" "	9.9	"	4	6.87	159.47	P.	H.	
1829	" "	10.0	σ Orionis A, C . .	4	14.97	155.22	P.	H.	D not visible.
1830	" "	10.1	" A, C . .	4	15.45	246.40	P.	H.	
1831	" "	10.1	" A, B . .	4	15.35	244.90	P.	H.	
1832	" "	10.2	" A, B . .	4	16.27	155.02	P.	H.	
1833	Feb. 16	6.1	λ Orionis A, B . .	4	21.42	157.52	P.	H.	Feb. 16. Thick haze, seeing worse than yesterday.
1834	" "	6.2	" A, B . .	4	22.32	158.92	P.	H.	
1835	" "	6.3	32 Eridani	4	27.60	158.20	P.	H.	
1836	" "	6.4	"	4	29.42	158.62	S.	H.	
1837	" "	6.5	"	4	29.92	158.12	P.	H.	
1838	" "	6.6	"	4	30.65	156.40	S.	H.	
1839	" "	6.9	α Geminorum A, B .	4	38.25	156.45	S.	H.	
1840	" "	7.0	" A, B .	4	40.02	156.27	S.	H.	
1841	" "	7.1	" A, B .	4	37.32	154.37	U.	H.	
1842	" "	7.1	" A, B .	4	36.47	154.47	U.	H.	
1843	" "	7.2	" A, B .	4	31.25	154.15	P.	H.	
1844	" "	7.2	" A, B .	4	33.47	156.92	P.	H.	
1845	" "	7.4	8 Monocerotis . .	4	20.80	246.45	P.	H.	
1846	" "	7.4	"	4	18.62	154.92	P.	H.	Erroneous reading 57.6 corrected to 47.6.
1847	" "	7.5	"	4	18.90	155.20	U.	H.	
1848	" "	7.6	"	4	20.57	244.67	U.	H.	
1849	" "	7.7	ζ Orionis A, B . .	4	19.42	160.07	P.	H.	
1850	" "	7.8	" A, B . .	4	21.82	248.52	P.	H.	Seeing bad.
1851	" "	7.8	" A, B . .	4	18.97	248.97	U.	H.	
1852	" "	7.9	" A, B . .	4	18.05	158.45	U.	H.	
1853	Feb. 18	5.9	α Geminorum A, B .	4	31.85	155.55	P.	H.	Feb. 18. Images large and unsteady.
1854	" "	5.9	" A, B .	4	32.50	157.30	P.	H.	
1855	" "	6.3	" A, C .	4	2.15	243.30	P.	H.	
1856	" "	6.4	" A, C .	4	2.92	242.32	S.	H.	Seeing poor.
1857	" "	6.6	" A, C .	4	1.92	151.67	P.	H.	
1858	" "	6.7	" A, C .	4	2.57	152.07	S.	H.	
1859	" "	6.9	" A, C .	4	2.55	152.05	U.	H.	
1860	" "	6.9	" A, C .	4	2.20	241.95	U.	H.	
Total Number . .				10158					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1861	Feb. 18	7.2	π Geminorum . .	4	5.40	242.30	S.	H.	
1862	" "	7.3	" " . .	4	4.82	153.17	S.	H.	
1863	" "	7.4	" " . .	4	5.05	153.35	U.	H.	
1864	" "	7.5	" " . .	4	5.32	243.12	U.	H.	
1865	" "	7.6	" " . .	4	4.75	242.60	P.	H.	Driving clock troublesome.
1866	" "	7.8	" " . .	4	4.92	153.02	P.	H.	
1867	" "	8.0	δ Geminorum . .	4	6.82	154.32	P.	H.	
1868	" "	8.0	" " . .	4	6.15	244.25	P.	H.	
1869	" "	8.0	" " . .	4	7.35	243.50	U.	H.	
1870	" "	8.2	" " . .	4	7.27	154.92	U.	H.	
1871	" "	8.5	γ Andromedæ . .	4	14.97	153.67	P.	H.	
1872	" "	8.6	" " . .	4	14.80	155.05	S.	H.	
1873	" "	8.6	" " . .	4	16.65	243.60	P.	H.	
1874	" "	8.7	" " . .	4	16.50	243.10	S.	H.	
1875	" "	8.8	η Persei	4	6.30	150.00	P.	H.	B very blue.
1876	" "	8.8	" "	4	6.72	239.97	P.	H.	
1877	" "	8.8	" "	4	7.60	241.00	U.	H.	{ A very golden, B only bluish.
1878	" "	8.9	" "	4	7.62	150.17	U.	H.	
1879	" "	8.9	" "	4	6.85	149.90	S.	H.	{ A decidedly yellow, B grayish-blue.
1880	" "	9.0	" "	4	5.20	239.70	S.	H.	
1881	" "	9.1	ϵ Persei	4	6.22	241.67	S.	H.	
1882	" "	9.2	" "	4	6.02	151.32	S.	H.	
1883	" "	9.3	" "	4	5.67	151.92	U.	H.	
1884	" "	9.3	" "	4	7.35	241.65	U.	H.	
1885	" "	9.5	η Tauri	4	11.25	150.15	P.	H.	
1886	" "	9.6	" "	4	13.85	148.95	S.	H.	
1887	" "	9.6	" "	4	12.80	239.35	P.	H.	Images about 45" apart.
1888	" "	9.7	" "	4	10.75	240.15	S.	H.	
1889	" "	9.7	" "	4	16.72	239.92	U.	H.	[blurred.
1890	" "	9.8	" "	4	14.25	148.35	U.	H.	Images very large and
1891	Feb. 19	6.2	α Canis Majoris A, B	6	.42	58.02	P.	H.	Images 0°, 3'.
1892	" "	6.3	" " A, B	6	.82	331.32	P.	H.	Index V, images 150°, 3'.
1893	" "	6.4	" " A, B	6	.55	331.52	S.	H.	Index V, 90°.
1894	" "	6.7	" " A, B	6	.47	151.60	U.	H.	Index O, 270°.
1895	" "	7.2	" " A, B	6	.62	60.68	U.	H.	Ind. V, 315°. Images 0°.
1896	" "	7.5	σ^2 40 Eridani A, BC	4	5.70	149.25	U.	H.	{ Seeing steady, but blurry. BC not separated.
1897	" "	7.6	" " A, BC	4	6.67	239.87	U.	H.	
1898	" "	7.7	" " A, BC	4	5.02	239.22	P.	H.	
1899	" "	7.7	" " A, BC	4	4.62	149.52	P.	H.	
1900	" "	7.8	39 Eridani	4	10.40	149.40	P.	H.	
1901	" "	7.8	" "	4	9.52	240.32	P.	H.	
1902	" "	7.9	" "	4	10.32	239.37	U.	H.	
1903	" "	7.9	" "	4	10.00	149.95	U.	H.	
1904	" "	8.7	π Arietis A, B . .	4	15.50	149.65	P.	H.	
1905	" "	8.8	" " A, B	4	14.27	241.37	P.	H.	[corrected to 137.8. Erroneous read'g 157.8,
1906	" "	8.8	" " A, B	4	15.87	245.02	S.	H.	
1907	" "	8.9	" " A, B	4	14.72	245.12	U.	H.	Brightness of images very variable.
1908	" "	9.0	" " A, B	4	15.40	156.80	S.	H.	
1909	" "	9.1	" " A, B	4	13.60	155.10	U.	H.	Seeing much worse.
1910	" "	9.3	ζ Persei	4	3.12	241.47	P.	H.	
1911	" "	9.4	" "	4	3.40	152.35	P.	H.	
1912	" "	9.4	" "	4	3.35	151.80	S.	H.	
1913	" "	9.5	" "	4	3.22	243.97	S.	H.	
1914	" "	9.6	" "	4	2.95	244.05	U.	H.	
1915	" "	9.7	" "	4	3.20	156.75	U.	H.	
1916	" "	9.8	σ Persei	4	5.60	155.75	P.	H.	
1917	" "	9.9	" "	4	6.40	244.80	P.	H.	
1918	" "	9.9	" "	4	6.40	245.45	S.	H.	
1919	" "	10.0	" "	4	6.47	155.57	S.	H.	
1920	" "	10.0	" "	4	6.60	155.75	U.	H.	
Total Number . .				10408					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1921	Feb. 19	10.1	α Persei	4	6.80	245.75	U.	H.	[not very clear. Feb. 24. Images steady, No. 1922. B redder than A.
1922	Feb. 24	6.5	α Canis Majoris B .	5	.744		P.	I.	
1923	" "	6.5	" " B .	5	.570		S.	I.	
1924	" "	6.8	β Orionis c	5	.668		P.	I.	
1925	" "	6.9	" c	5	.762		S.	I.	
1926	" "	7.5	σ Orionis A, D . .	4	4.82	242.22	P.	H.	
1927	" "	7.6	" A, D	4	5.42	152.42	P.	H.	
1928	" "	7.8	τ Orionis B	5	4.106		P.	I.	
1929	" "	7.9	" CD	5	2.648		P.	I.	
1930	" "	8.2	β Eridani	5	1.456		P.	I.	
1931	" "	8.2	"	5	1.198		S.	I.	} Light cut off from prism. Reject. } C not seen.
1932	" "	8.4	σ^2 40 Eridani D .	5	2.554		P.	I.	
1933	" "	8.5	" D	5	2.012		S.	I.	
1934	" "	8.6	γ Orionis	5	.694		P.	I.	
1935	" "	8.7	"	5	.516		S.	I.	
1936	" "	8.9	σ^2 Orionis	5	2.316		P.	I.	
1937	" "	8.9	"	5	2.922		S.	I.	
1938	" "	9.4	α Tauri B	5	1.240		S.	I.	
1939	" "	9.5	" B	5	1.314		P.	I.	
1940	" "	9.9	γ Cassiopeiæ . .	5	.892		S.	I.	[1.480. Rejecting 2.17 mean = Feb. 26. Not very clear, images steady.
1941	" "	10.0	"	5	1.032		P.	I.	
1942	Feb. 26	6.5	β Eridani	6	1.595		P.	I.	
1943	" "	6.6	"	5	.988		S.	I.	
1944	" "	6.8	"	5	1.522		U.	I.	
1945	" "	7.0	β Orionis D	5	.326		S.	I.	
1946	" "	7.1	" D	5	.388		U.	I.	
1947	" "	7.2	" c	5	.670		P.	I.	
1948	" "	7.3	" c	5	.502		U.	I.	
1949	" "	7.5	τ Orionis B	5	3.734		P.	I.	B too bright for meas- urement.
1950	" "	7.9	" CD	5	2.572		P.	I.	
1951	" "	8.0	" CD	5	2.114		U.	I.	
1952	" "	8.7	σ^2 Orionis	5	2.132		P.	I.	
1953	" "	8.8	"	5	1.882		S.	I.	
1954	" "	9.0	γ Orionis	5	.468		S.	I.	
1955	" "	9.1	"	5	.602		U.	I.	
1956	" "	9.2	"	5	.570		P.	I.	
1957	" "	9.2	α Canis Minoris .	6	.752		P.	I.	
1958	" "	9.4	" "	5	.684		U.	I.	Index V, 225°. } Index V, 270°. } Index O, 270°. Feb. 27. Clearer, images less steady than 26th.
1959	" "	9.5	" "	5	.796		S.	I.	
1960	" "	9.9	β Canis Minoris E .	5	.546		S.	I.	
1961	" "	10.0	" " E	5	.608		P.	I.	
1962	" "	10.1	" " c	5	1.244		P.	I.	
1963	" "	10.1	" " E	5	.676		U.	I.	
1964	" "	10.2	" " F	5	.586		U.	I.	
1965	" "	10.3	" " c	5	1.408		U.	I.	
1966	Feb. 27	6.4	α Canis Majoris A, B	6	.67	63.93	P.	H.	
1967	" "	6.6	" " A, B .	6	.43	65.03	U.	H.	Feb. 27. Clearer, images less steady than 26th.
1968	" "	6.7	" " A, B .	6	.53	65.03	S.	H.	
1969	" "	6.8	" " A, B .	6	.82	332.88	S.	H.	
1970	" "	6.9	" " A, B .	6	.60	332.60	U.	H.	
1971	" "	7.4	η Cephei B	5	2.016		P.	I.	
1972	" "	7.4	" c	5	1.312		P.	I.	
1973	" "	7.5	" c	5	1.000		U.	I.	
1974	" "	7.6	" B	5	2.070		U.	I.	
1975	" "	7.8	γ Cephei	5	1.486		P.	I.	
1976	" "	7.9	"	5	1.292		U.	I.	
1977	" "	8.1	γ Cassiopeiæ . .	5	.986		P.	I.	
1978	" "	8.2	"	5	.804		U.	I.	
1979	" "	8.4	"	5	.784		S.	I.	
1980	" "	9.0	θ Persei	4	4.80	246.15	P.	H.	
Total Number . .				10711					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
1981	Feb. 27	9.0	θ Persei	4	4.40	156.40	P.	H.	
1982	" "	9.0	"	4	4.12	156.32	S.	H.	
1983	" "	9.1	"	4	3.72	246.97	S.	H.	
1984	" "	9.1	"	4	3.27	246.72	U.	H.	
1985	" "	9.2	"	4	3.55	156.25	U.	H.	
1986	" "	9.5	Star, α Leonis . .	5	1.586		S.	I.	Star n. f. Uranus.
1987	Feb. 28	7.1	α Ursæ Minoris .	5	1.272		U.	I.	} Aperture 12.7 cms.
1988	" "	7.4	" "	5	1.608		P.	I.	
1989	Mar. 1	7.9	σ^2 40 Eridani D .	5	2.548		P.	I.	March 1. Seeing pretty good.
1990	" "	8.0	" C	5	3.590		P.	I.	
1991	" "	8.0	" D	5	2.302		U.	I.	
1992	" "	8.2	" C	5	3.198		U.	I.	
1993	" "	8.5	τ Orionis CD . .	5	1.798		S.	I.	
1994	" "	8.6	" B	5	4.066		S.	I.	
1995	" "	8.8	" B	5	3.972		U.	I.	
1996	" "	8.9	" CD	5	2.720		U.	I.	
1997	" "	9.5	Titania, α Leonis .	5	.432		U.	I.	
1998	" "	9.7	" "	5	.400		S.	I.	
1999	" "	9.7	" "	5	.510		P.	I.	
2000	" "	9.9	" Uranus	5	2.766		P.	I.	
2001	" "	10.0	" "	5	1.996		S.	I.	
2002	" "	10.2	" "	5	2.664		U.	I.	Oberon seen. [high.
2003	Mar. 4	6.9	ψ Cassiopeiæ A, BC	4	5.12	155.72	S.	H.	Seeing 2, 5, 2. Wind
2004	" "	6.9	" A, BC	4	9.10	246.55	S.	H.	March 4. Average seeing 5, 5, 2.
2005	" "	7.1	" A, BC	4	8.30	246.35	U.	H.	
2006	" "	7.1	" A, BC	4	7.80	154.85	U.	H.	
2007	" "	7.3	39 Eridani	4	12.27	155.37	P.	H.	
2008	" "	7.3	"	4	11.35	245.55	P.	H.	
2009	" "	7.4	"	4	9.32	246.17	U.	H.	
2010	" "	7.5	"	4	9.10	155.95	U.	H.	Stars scarcely visible.
2011	" "	7.7	11 Monocerotis A, B	4	39.92	157.52	P.	H.	B between A and C.
2012	" "	7.8	" A, B	4	37.87	157.87	P.	H.	
2013	" "	7.8	" A, B	4	37.32	156.37	U.	H.	
2014	" "	7.9	" A, B	4	40.10	155.30	U.	H.	
2015	" "	8.1	8 Monocerotis . .	4	20.47	243.12	P.	H.	Seeing 7, 4, 3.
2016	" "	8.1	"	4	19.17	154.27	P.	H.	Dome partly covers object-glass.
2017	" "	8.2	"	4	20.22	152.92	U.	H.	
2018	" "	8.3	"	4	19.52	243.27	U.	H.	
2019	Mar. 5	6.1	α Canis Majoris B .	5	.750		P.	I.	March 5. Seeing 8, 8, 8.
2020	" "	6.5	π Arietis A, B . .	4	15.30	245.65	P.	H.	
2021	" "	6.6	" A, B	4	15.10	156.35	P.	H.	
2022	" "	6.9	ι Cassiopeiæ A, B .	4	14.80	246.40	U.	H.	
2023	" "	7.0	" A, B	4	14.57	156.92	U.	H.	
2024	" "	7.1	" A, C	4	9.75	154.80	U.	H.	
2025	" "	7.2	" A, C	4	10.57	244.62	U.	H.	
2026	" "	7.2	" A, C	4	10.97	244.52	P.	H.	
2027	" "	7.3	" A, C	4	12.25	154.70	P.	H.	
2028	" "	7.3	" A, B	4	17.97	245.57	P.	H.	
2029	" "	7.4	" A, B	4	21.05	154.55	P.	H.	
2030	" "	8.0	Titania, Uranus . .	5	3.342		P.	I.	
2031	" "	8.0	" α Leonis	5	.638		P.	I.	
2032	" "	8.1	" "	6	.455		U.	I.	
2033	" "	8.5	" Uranus	5	2.678		U.	I.	
2034	" "	8.7	β Eridani	5	1.428		P.	I.	
2035	" "	8.8	"	5	1.830		U.	I.	
2036	" "	8.9	τ Orionis B	5	2.996		P.	I.	
2037	" "	8.9	" B	5	4.526		U.	I.	
2038	" "	9.3	" CD	5	2.322		P.	I.	
2039	" "	9.3	" CD	5	2.824		U.	I.	
2040	" "	9.6	11 Monocerotis B, C	4	39.02	152.32	P.	H.	Index O, 135°.
Total Number . .				10980					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2041	Mar. 5	9.7	11 Monocerotis B, C	4	41.32	154.47	P.	H.	} Index V. Index O.
2042	" "	9.7	" B, C	4	35.70	155.90	U.	H.	
2043	" "	9.8	" B, C	4	38.55	155.15	U.	H.	
2044	" "	9.9	" A, B	4	37.72	155.27	U.	H.	
2045	" "	9.9	" A, B	4	37.05	154.55	U.	H.	
2046	" "	10.0	" A, B	4	38.77	153.77	P.	H.	
2047	" "	10.0	" A, B	4	39.45	154.10	P.	H.	} Seldom clearly defined. Red star. March 8. Seeing 7, 8, 5.
2048	Mar. 6	6.9	α Canis Majoris B.	5	.642		U.	I.	
2049	" "	7.3	π Leporis . . .	4	16.95	247.15	U.	H.	
2050	" "	7.4	" . . .	4	17.17	158.12	U.	H.	
2051	" "	7.7	μ Canis Majoris . . .	4	18.72	156.72	U.	H.	
2052	" "	7.8	" " . . .	4	18.92	249.72	U.	H.	
2053	Mar. 8	6.5	α Orionis . . .	5	1.048		P.	I.	} Doubtful which companion was observed.
2054	" "	6.8	ι Leporis . . .	4	5.37	156.97	P.	H.	
2055	" "	6.8	" . . .	4	6.17	246.32	P.	H.	
2056	" "	6.9	" . . .	4	5.20	246.20	U.	H.	
2057	" "	7.0	" . . .	4	5.55	156.60	U.	H.	
2058	" "	7.1	π Leporis . . .	4	14.47	159.22	U.	H.	
2059	" "	7.2	" . . .	4	13.42	251.37	U.	H.	} B blue. Images unsymmetrical.
2060	" "	7.3	γ Orionis . . .	5	.604		P.	I.	
2061	" "	7.3	" . . .	5	.512		U.	I.	
2062	" "	7.5	σ^2 Orionis . . .	5	2.652		P.	I.	
2063	" "	7.6	" . . .	5	2.852		U.	I.	
2064	" "	7.9	η Cephei c . . .	5	1.828		P.	I.	
2065	" "	8.0	" B . . .	5	1.800		P.	I.	} Star supposed at the time to be Umbriel. March 9. Seeing 7, 5, 5.
2066	" "	8.1	" . . .	5	1.664		U.	I.	
2067	" "	8.3	" . . .	5	1.884		U.	I.	
2068	" "	8.4	4 H. Camelopardali	4	6.07	250.52	P.	H.	
2069	" "	8.5	" " . . .	4	7.22	158.87	P.	H.	
2070	" "	8.7	η Persei . . .	4	5.92	247.07	P.	H.	
2071	" "	8.7	" . . .	4	6.15	156.85	P.	H.	} Through red glass. Through blue glass.
2072	" "	8.8	θ Persei . . .	4	4.85	157.90	P.	H.	
2073	" "	8.9	" . . .	4	5.25	247.35	P.	H.	
2074	" "	9.0	ε Persei . . .	4	5.27	247.72	P.	H.	
2075	" "	9.0	" . . .	4	5.17	157.82	P.	H.	
2076	" "	9.3	Oberon, Uranus . . .	5	2.644		P.	I.	
2077	" "	9.4	" α Leonis . . .	5	.386		P.	I.	} Star near Oberon interferes. B blue.
2078	" "	9.6	" Uranus . . .	5	2.576		U.	I.	
2079	" "	9.6	" α Leonis . . .	5	.418		U.	I.	
2080	" "	9.8	Star, α Leonis . . .	6	.405		U.	I.	
2081	" "	10.0	" " . . .	5	.428		P.	I.	
2082	Mar. 9	6.5	α Canis Majoris B.	5	.724		P.	I.	
2083	" "	7.2	π Leporis . . .	4	18.70	160.40	P.	H.	} Through red glass. Through blue glass.
2084	" "	7.3	" . . .	4	18.12	251.12	P.	H.	
2085	" "	7.4	σ^2 40 Eridani A, BC	4	4.85	249.00	P.	H.	
2086	" "	7.5	" A, BC	4	4.60	159.65	P.	H.	
2087	" "	7.6	" A, BC	5	4.264		P.	I.	
2088	" "	8.0	γ Andromedæ . . .	4	13.82	248.02	P.	H.	
2089	" "	8.0	" . . .	4	15.00	157.30	P.	H.	} Star near Oberon interferes. B blue.
2090	" "	8.1	" . . .	4	12.57	158.57	P.	H.	
2091	" "	8.1	" . . .	4	12.37	248.62	P.	H.	
2092	" "	8.2	" . . .	4	16.90	249.15	P.	H.	
2093	" "	8.3	" . . .	4	16.72	159.12	P.	H.	
2094	" "	8.6	π Puppis . . .	4	46.42	159.82	P.	H.	
2095	" "	8.7	" . . .	4	45.87	160.92	P.	H.	} Star near Oberon interferes. B blue.
2096	" "	9.0	Oberon, α Leonis . . .	5	.468		P.	I.	
2097	" "	9.1	" Uranus . . .	5	2.684		P.	I.	
2098	" "	9.8	τ Leonis . . .	4	16.12	163.17	P.	H.	
2099	" "	9.8	" . . .	4	16.35	252.35	P.	H.	
2100	" "	9.9	83 Leonis . . .	4	28.55	163.65	P.	H.	
Total Number . . .				11241					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2101	Mar. 9	10.0	83 Leonis . . .	4	31.12	160.32	P.	H.	Dome begins to cover object-glass. Mar. 10. Seeing 2, 8, 8.
2102	Mar. 10	7.4	γ Leonis . . .	4	31.85	162.10	P.	H.	
2103	" "	7.5	" . . .	4	31.50	160.90	P.	H.	
2104	" "	7.7	ϵ Hydræ . . .	4	12.12	162.97	P.	H.	
2105	" "	7.7	" . . .	4	11.25	252.05	P.	H.	Very close.
2106	" "	7.9	54 Leonis . . .	4	20.57	160.97	P.	H.	
2107	" "	8.0	" . . .	4	23.82	162.87	P.	H.	
2108	" "	8.1	ξ Ursæ Majoris .	4	39.80	158.75	P.	H.	
2109	" "	8.2	" " . . .	4	38.17	157.52	P.	H.	{ With care.
2110	" "	8.9	ι Leonis . . .	4	19.07	251.72	P.	H.	
2111	" "	8.9	" . . .	4	19.90	159.65	P.	H.	
2112	" "	9.0	12 Canum Venat. .	4	15.35	161.55	P.	H.	
2113	" "	9.1	" " . . .	4	15.57	251.47	P.	H.	{ Bootis in original, probably by mistake.
2114	" "	9.2	ζ Ursæ Majoris .	4	24.20	160.65	P.	H.	
2115	" "	9.2	" " . . .	4	23.75	159.80	P.	H.	
2116	" "	9.5	α Bootis . . .	4	21.30	249.60	P.	H.	
2117	" "	9.5	" . . .	4	21.55	160.15	P.	H.	Mar. 15. Seeing 5, 4, 4.
2118	Mar. 15	7.5	δ Geminorum . .	4	9.17	252.67	U.	H.	
2119	" "	7.6	" . . .	4	8.42	161.72	U.	H.	
2120	" "	7.8	λ Geminorum . .	4	2.82	248.27	U.	H.	
2121	" "	7.8	" . . .	4	2.97	158.42	U.	H.	{ With care.
2122	" "	7.9	ζ Canceri AB, C .	4	34.25	161.25	P.	H.	
2123	" "	8.0	" AB, C . . .	4	35.45	162.20	P.	H.	
2124	" "	8.0	" AB, C . . .	4	31.65	161.70	U.	H.	
2125	" "	8.1	" AB, C . . .	4	31.37	159.97	U.	H.	One image nebulous, other oblong.
2126	" "	8.2	ϵ Hydræ . . .	4	14.75	159.25	P.	H.	
2127	" "	8.2	" . . .	5	17.60	160.80	P.	H.	
2128	" "	8.3	" . . .	4	12.40	252.90	U.	H.	
2129	" "	8.4	" . . .	4	12.10	162.25	U.	H.	{ With care.
2130	" "	8.5	54 Leonis . . .	4	25.97	161.77	P.	H.	
2131	" "	8.5	" . . .	4	24.60	161.80	P.	H.	
2132	" "	8.6	" . . .	4	22.45	161.50	U.	H.	
2133	" "	8.6	" . . .	4	21.57	250.57	U.	H.	Mar. 16. Seeing 4, 6, 3.
2134	" "	8.8	12 Canum Venat. .	4	17.40	161.15	P.	H.	
2135	" "	8.8	" " . . .	4	18.57	249.47	P.	H.	
2136	" "	8.8	" " . . .	4	17.90	251.15	U.	H.	
2137	" "	8.9	" " . . .	4	17.42	159.47	U.	H.	Mar. 16. Seeing 4, 6, 3.
2138	" "	9.0	ζ Ursæ Majoris .	4	25.52	162.12	P.	H.	
2139	" "	9.0	" " . . .	4	22.82	250.92	P.	H.	
2140	" "	9.0	" " . . .	4	26.42	251.07	U.	H.	
2141	" "	9.1	" " . . .	4	27.20	161.45	U.	H.	Mar. 16. Seeing 4, 6, 3.
2142	" "	9.2	τ Leonis . . .	4	14.20	157.60	P.	H.	
2143	" "	9.3	" . . .	4	15.15	248.15	P.	H.	
2144	" "	9.4	" . . .	4	17.63	218.83	U.	H.	
2145	" "	9.5	" . . .	4	20.15	160.30	U.	H.	Mar. 16. Seeing 4, 6, 3.
2146	" "	9.6	83 Leonis . . .	4	30.70	160.20	P.	H.	
2147	" "	9.6	" . . .	4	32.17	158.57	P.	H.	
2148	" "	9.7	" . . .	4	34.42	159.07	U.	H.	
2149	" "	9.7	" . . .	4	33.62	157.62	U.	H.	Mar. 16. Seeing 4, 6, 3.
2150	Mar. 16	7.5	γ Leporis . . .	4	18.72	245.22	P.	H.	
2151	" "	7.6	" . . .	4	20.62	154.32	P.	H.	
2152	" "	7.7	η Tauri . . .	4	11.70	154.10	P.	H.	
2153	" "	7.8	" . . .	4	11.50	243.45	P.	H.	Mar. 16. Seeing 4, 6, 3.
2154	" "	8.0	ϵ Persei . . .	4	5.80	246.30	P.	H.	
2155	" "	8.1	" . . .	4	5.30	155.80	P.	H.	
2156	" "	8.2	" . . .	4	5.57	156.22	S.	H.	
2157	" "	8.3	" . . .	4	7.25	246.00	S.	H.	Mar. 16. Seeing 4, 6, 3.
2158	" "	8.3	η Persei . . .	4	6.17	244.37	P.	H.	
2159	" "	8.4	" . . .	4	5.72	245.17	S.	H.	
2160	" "	8.5	" . . .	4	6.82	154.32	P.	H.	
Total Number . .				11482					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo- meter.	Remarks.
2161	Mar. 16	8.5	η Persei . . .	4	6.47	154.07	S.	H.	
2162	" "	8.6	26 Aurigæ . . .	4	13.35	154.95	P.	H.	
2163	" "	8.7	" . . .	4	13.60	154.80	S.	H.	
2164	" "	8.7	" . . .	4	14.02	246.77	P.	H.	
2165	" "	8.8	" . . .	4	15.02	246.52	S.	H.	
2166	" "	8.9	14 Aurigæ . . .	4	13.45	246.60	S.	H.	
2167	" "	9.0	" . . .	4	12.70	247.25	P.	H.	
2168	" "	9.0	" . . .	4	15.50	157.40	S.	H.	
2169	" "	9.1	" . . .	4	16.30	157.10	P.	H.	
2170	" "	9.1	ω Aurigæ . . .	4	17.45	246.65	P.	H.	
2171	" "	9.2	" . . .	4	13.47	247.07	S.	H.	
2172	" "	9.2	" . . .	4	14.77	157.07	P.	H.	
2173	" "	9.2	" . . .	4	17.22	157.77	S.	H.	
2174	" "	9.4	19 Camelopardali .	4	11.60	157.30	P.	H.	
2175	" "	9.4	" . . .	4	12.22	157.07	S.	H.	
2176	" "	9.5	" . . .	4	9.20	247.60	P.	H.	
2177	" "	9.5	" . . .	4	9.87	247.27	S.	H.	
2178	" "	9.6	δ Geminorum . .	4	7.35	157.70	P.	H.	
2179	" "	9.7	" . . .	4	6.47	158.37	S.	H.	
2180	" "	9.7	" . . .	4	6.77	247.27	P.	H.	
2181	" "	9.8	" . . .	4	7.45	247.60	S.	H.	
2182	" "	9.8	λ Geminorum . .	4	3.40	157.75	P.	H.	
2183	" "	9.9	" . . .	4	3.57	247.67	P.	H.	
2184	" "	9.9	" . . .	4	4.17	247.22	S.	H.	
2185	" "	10.0	" . . .	4	4.15	157.85	S.	H.	
2186	Mar. 19	7.7	π Arietis A, C . .	4	3.85	156.85	P.	H.	Mar. 19. Seeing 5, 4, 4.
2187	" "	7.8	" A, C . .	4	4.50	246.90	P.	H.	
2188	" "	7.9	" A, C . .	4	3.50	247.00	U.	H.	
2189	" "	7.9	" A, C . .	4	3.90	156.95	U.	H.	
2190	" "	8.3	41 Arietis . . .	4	5.35	243.30	P.	H.	
2191	" "	8.3	" . . .	4	4.55	154.50	P.	H.	
2192	" "	8.4	" . . .	4	2.50	154.20	U.	H.	Reflected image.
2193	" "	8.5	" . . .	4	5.90	154.55	U.	H.	
2194	" "	8.5	" . . .	4	7.27	243.62	U.	H.	
2195	" "	8.6	ζ Persei . . .	4	3.30	245.45	P.	H.	
2196	" "	8.7	" . . .	4	3.02	154.77	P.	H.	
2197	" "	8.7	" . . .	4	2.77	154.82	U.	H.	
2198	" "	8.7	" . . .	4	3.22	244.97	U.	H.	
2199	" "	8.8	ϵ Cassiopeiæ A, B .	4	22.35	244.75	P.	H.	
2200	" "	8.9	" A, B . .	4	21.37	156.82	P.	H.	
2201	" "	8.9	" A, C . .	4	11.45	154.35	P.	H.	} Clouds.
2202	" "	8.9	" A, C . .	4	12.50	243.75	P.	H.	
2203	" "	9.2	" A, C . .	4	11.82	243.52	U.	H.	
2204	" "	9.2	" A, C . .	4	12.10	152.05	U.	H.	Seeing better.
2205	" "	9.5	ω Aurigæ . . .	4	20.85	245.70	U.	H.	Seeing very variable.
2206	" "	9.6	" . . .	4	18.45	154.65	U.	H.	
2207	" "	9.7	" . . .	4	17.67	242.87	P.	H.	
2208	" "	9.7	" . . .	4	15.10	153.85	P.	H.	
2209	" "	9.8	14 Aurigæ . . .	4	12.95	153.50	P.	H.	
2210	" "	9.8	" . . .	4	13.72	243.92	P.	H.	
2211	" "	9.9	" . . .	4	16.17	242.82	U.	H.	
2212	" "	9.9	" . . .	4	15.30	153.25	U.	H.	
2213	Mar. 20	6.7	η Tauri . . .	4	9.92	153.02	P.	H.	Through clouds.
2214	" "	6.7	" . . .	4	13.07	243.77	P.	H.	Image of A elongated.
2215	" "	6.8	" . . .	4	14.27	243.77	U.	H.	Very faint, clouds.
2216	" "	6.8	" . . .	4	12.80	153.30	U.	H.	Mar. 20. Seeing 8, 6, 5.
2217	" "	7.1	ζ Persei . . .	4	2.97	154.22	U.	H.	
2218	" "	7.2	" . . .	4	3.42	244.07	U.	H.	
2219	" "	7.2	" . . .	4	3.60	243.90	P.	H.	
2220	" "	7.3	" . . .	4	3.37	152.77	P.	H.	
Total Number . .				11722					

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No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.		
2221	Mar. 20	7.4	α Persei	4	6.00	152.90	P.	H.	Clear.		
2222	" "	7.4	"	4	6.35	241.95	P.	H.			
2223	" "	7.5	"	4	6.20	242.85	U.	H.			
2224	" "	7.5	"	4	6.40	152.95	U.	H.			
2225	" "	7.7	π Arietis Δ, C . .	4	5.20	152.30	P.	H.			
2226	" "	7.8	" Δ, C . .	4	4.10	242.70	P.	H.			
2227	" "	7.9	" Δ, C . .	4	3.40	243.10	U.	H.			
2228	" "	8.0	" Δ, C . .	4	3.40	152.85	U.	H.			
2229	" "	8.3	30 Tauri	4	7.77	153.72	P.	H.			
2230	" "	8.3	"	4	9.00	243.05	P.	H.			
2231	" "	8.3	"	4	8.27	243.02	U.	H.	Clouds and strong wind.		
2232	" "	8.4	"	4	9.87	153.82	U.	H.			
2233	" "	8.5	α Tauri	4	.75	242.40	P.	H.			
2234	" "	8.6	"	4	.50	152.65	P.	H.			
2235	" "	9.1	θ Persei	4	4.30	243.15	P.	H.			
2236	" "	9.1	"	4	4.50	153.45	P.	H.		Wind shakes telescope.	
2237	" "	9.2	"	4	4.50	153.65	U.	H.			
2238	" "	9.2	"	4	4.35	243.15	U.	H.			
2239	" "	9.3	26 Aurigæ	4	14.22	243.22	P.	H.			
2240	" "	9.3	"	4	13.05	154.00	P.	H.			
2241	" "	9.4	"	4	13.67	152.72	U.	H.			
2242	" "	9.4	"	4	14.10	242.80	U.	H.			
2243	" "	9.6	λ Orionis Δ, C . .	4	1.92	243.07	U.	H.	A out of field.		
2244	" "	9.6	" Δ, C . .	4	2.07	153.17	U.	H.			
2245	" "	9.7	" Δ, C . .	4	2.02	153.12	P.	H.			
2246	" "	9.8	" Δ, C . .	4	2.25	243.55	P.	H.			
2247	Mar. 21	7.0	41 Arietis	4	4.77	153.22	P.	H.		Mar. 21. Seeing, 4, 8, 8.	
2248	" "	7.1	"	4	4.80	243.65	P.	H.			
2249	" "	7.1	"	4	6.20	243.45	U.	H.			
2250	" "	7.2	"	4	5.85	153.80	U.	H.			
2251	" "	7.3	2 H. Camelopardali	4	9.17	154.67	P.	H.			Very difficult.
2252	" "	7.4	"	4	12.52	245.17	P.	H.			
2253	" "	7.4	"	4	6.92	245.97	U.	H.	B barely seen.		
2254	" "	7.6	"	4	7.90	156.05	U.	H.			
2255	" "	7.8	11 Monocerotis B, C	4	41.17	155.62	P.	H.			
2256	" "	7.8	" B, C	4	41.82	157.42	P.	H.			
2257	" "	7.9	" B, C	4	37.02	156.77	U.	H.			
2258	" "	8.0	" B, C	4	37.00	156.80	U.	H.			
2259	" "	8.2	" A, B	4	36.85	155.50	U.	H.			
2260	" "	8.2	" A, B	4	38.92	153.62	U.	H.			
2261	" "	8.3	" A, B	4	40.07	154.47	P.	H.			
2262	" "	8.3	" A, B	4	38.67	152.17	P.	H.		Seeing very bad, clouds. Seeing good.	
2263	" "	8.5	ε Hydræ	4	13.07	244.72	P.	H.			
2264	" "	8.5	"	4	11.70	154.60	P.	H.			
2265	" "	8.6	"	4	12.05	156.35	U.	H.			
2266	" "	8.7	"	5	11.25	244.00	U.	H.			
2267	" "	8.9	ι Leonis	4	15.40	156.30	P.	H.			
2268	" "	9.0	"	5	14.90	247.00	P.	H.			
2269	Mar. 22	7.0	30 Tauri	4	7.85	246.45	P.	H.			
2270	" "	7.1	"	4	7.55	156.75	P.	H.			
2271	" "	7.1	"	4	8.00	157.30	U.	H.			
2272	" "	7.2	"	4	9.52	247.37	U.	H.			
2273	" "	7.3	α Tauri	4	.92	245.42	U.	H.			
2274	" "	7.3	"	4	.65	155.65	U.	H.			
2275	" "	7.4	"	4	.62	155.52	P.	H.			
2276	" "	7.4	"	4	.87	245.27	P.	H.			
2277	" "	7.5	λ Orionis Δ, C . .	4	2.55	246.40	P.	H.			
2278	" "	7.5	" Δ, C . .	4	2.35	156.60	P.	H.			
2279	" "	7.6	" Δ, C . .	4	1.95	152.55	U.	H.			
2280	" "	7.6	" Δ, C . .	4	1.77	241.87	U.	H.			
Total Number . .				11964							

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2281	Mar. 22	8.5	Star, Uranus . .	5	2.986		P.	I.	Object taken for Ariel.
2282	" "	8.6	Oberon, Uranus .	5	3.510		P.	I.	
2283	" "	8.8	Star, Uranus . .	5	2.642		U.	I.	Object taken for Ariel.
2284	" "	8.9	Oberon, Uranus .	5	3.356		U.	I.	
2285	" "	9.1	Titania, " . .	5	3.394		P.	I.	
2286	" "	9.2	" " . .	5	2.164		U.	I.	
2287	" "	9.4	" α Leonis . .	5	.536		P.	I.	
2288	" "	9.5	" " . .	5	.452		U.	I.	
2289	" "	9.6	ι Leonis	4	16.95	247.10	P.	H.	
2290	" "	9.7	"	4	17.12	158.37	P.	H.	
2291	" "	9.7	"	4	13.90	158.60	U.	H.	
2292	" "	9.8	"	4	12.27	249.42	U.	H.	Images reset.
2293	Mar. 23	7.2	41 Arietis . . .	4	4.27	155.22	P.	H.	Mar. 23. Seeing 4, 6, 5.
2294	" "	7.3	"	4	4.15	245.50	P.	H.	Hazy.
2295	" "	7.9	τ Tauri	4	14.10	244.75	P.	H.	
2296	" "	8.0	"	4	15.97	155.42	P.	H.	
2297	" "	8.1	88 Tauri	4	11.37	154.02	P.	H.	
2298	" "	8.2	"	4	13.12	245.02	P.	H.	
2299	" "	8.3	14 Aurigæ . . .	4	14.20	245.95	P.	H.	
2300	" "	8.3	"	4	14.47	155.77	P.	H.	
2301	" "	8.5	26 Aurigæ . . .	4	16.62	153.37	P.	H.	Companion very faint.
2302	" "	8.6	"	4	17.32	245.17	P.	H.	
2303	" "	9.1	ω Aurigæ . . .	4	16.07	245.37	P.	H.	
2304	" "	9.2	"	4	16.27	154.97	P.	H.	
2305	" "	9.4	11 Monocerotis B, C	4	44.20	157.65	P.	H.	Poor. Perhaps 45.80.
2306	Mar. 25	8.6	λ Geminorum . .	4	3.00	156.55	U.	H.	Mar. 25. Seeing 9, 6, 5.
2307	" "	8.7	"	4	3.17	244.62	U.	H.	Very windy.
2308	" "	9.0	ι Cancri	4	15.40	241.45	U.	H.	
2309	" "	9.1	"	4	18.15	153.65	U.	H.	
2310	" "	9.5	ν Ursæ Majoris .	4	5.27	157.82	U.	H.	Wind subsided.
2311	" "	9.6	" "	4	6.47	248.82	U.	H.	
2312	" "	9.7	24 Comæ Berenices	4	24.80	154.65	U.	H.	
2313	" "	9.8	" "	4	30.45	243.45	U.	H.	Images larger than in last set.
2314	Mar. 26	7.5	π Arietis A, C . .	4	4.37	243.37	P.	H.	
2315	" "	7.5	" A, C	4	3.95	154.30	P.	H.	
2316	" "	7.6	" A, C	4	3.57	154.02	U.	H.	B near limit of visibility.
2317	" "	7.7	" A, C	4	3.92	244.07	U.	H.	
2318	" "	7.8	σ Persei	4	5.12	153.97	P.	H.	
2319	" "	7.9	"	4	6.80	243.70	P.	H.	Images look brighter.
2320	" "	7.9	"	4	6.17	243.67	U.	H.	
2321	" "	8.0	"	4	5.57	154.07	U.	H.	
2322	" "	8.2	2 H. Camelopardali	4	6.82	157.82	U.	H.	
2323	" "	8.3	"	4	7.52	247.97	U.	H.	
2324	" "	8.4	"	4	11.32	247.42	P.	H.	Images too close.
2325	" "	8.5	"	4	9.60	158.15	P.	H.	Images perhaps too distant.
2326	" "	8.6	4 H. Camelopardali	4	7.10	155.90	P.	H.	
2327	" "	8.6	"	4	6.80	246.25	P.	H.	
2328	" "	8.7	"	4	6.65	246.10	U.	H.	
2329	" "	8.7	"	4	6.42	156.47	U.	H.	
2330	" "	8.9	7 H. Camelopardali	4	3.25	157.30	P.	H.	
2331	" "	9.0	"	4	3.37	246.62	P.	H.	
2332	" "	9.1	"	4	3.02	247.12	U.	H.	
2333	" "	9.1	"	4	2.82	158.12	U.	H.	
2334	Mar. 30	8.1	η Tauri	4	12.20	241.35	P.	H.	Mar. 30. Seeing 5, 6, 3.
2335	" "	8.1	"	4	11.25	150.50	P.	H.	
2336	" "	8.2	"	4	14.15	151.05	S.	H.	
2337	" "	8.3	"	4	13.32	241.02	S.	H.	
2338	" "	8.4	ψ Cassiopeiæ A, BC	4	6.62	150.52	P.	H.	Clouds.
2339	" "	8.7	α Tauri	4	1.15	152.00	S.	H.	
2340	" "	8.8	"	4	.80	242.25	S.	H.	
Total Number . .				12212					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2341	Mar. 30	8.8	α Tauri	4	.57	242.27	P.	H.	Too hazy to continue.
2342	" "	9.0	λ Orionis A, C . .	4	1.87	242.97	P.	H.	A out of field.
2343	" "	9.0	" A, C	4	2.32	152.67	P.	H.	
2344	" "	9.1	" A, C	4	2.22	153.02	S.	H.	
2345	" "	9.3	" A, C	4	2.12	242.87	S.	H.	
2346	" "	9.9	γ Leonis	4	27.12	155.72	S.	H.	
2347	" "	10.0	"	4	31.37	156.77	P.	H.	
2348	" "	10.0	"	4	34.72	156.77	S.	H.	
2349	" "	10.2	"	4	30.15	157.85	P.	H.	
2350	Mar. 31	6.9	β Orionis	4	2.90	157.50	P.	H.	Mar. 31. Seeing 6, 6, 4.
2351	" "	6.9	"	4	2.90	247.45	P.	H.	
2352	" "	7.0	δ Orionis	4	6.97	157.32	P.	H.	
2353	" "	7.1	"	4	7.65	247.10	P.	H.	
2354	" "	7.5	γ Leporis	4	19.05	243.45	P.	H.	B red.
2355	" "	7.6	"	4	17.47	152.47	P.	H.	
2356	" "	7.7	η Tauri	4	10.95	152.80	P.	H.	
2357	" "	7.7	"	4	10.62	243.02	P.	H.	
2358	" "	7.8	α Tauri	6	.37	153.10	P.	H.	No complete disappearance.
2359	" "	7.9	"	4	.72	242.62	P.	H.	
2360	" "	8.0	41 Arietis	4	4.15	152.85	P.	H.	
2361	" "	8.1	"	4	4.52	243.07	P.	H.	
2362	" "	8.2	"	4	3.37	242.62	S.	H.	
2363	" "	8.3	"	4	2.67	152.47	S.	H.	
2364	" "	8.5	ψ Cassiopeiæ A, BC	4	5.82	243.87	P.	H.	
2365	" "	8.5	" A, BC	4	6.30	244.00	S.	H.	
2366	" "	8.6	" A, BC	4	5.85	154.25	P.	H.	
2367	" "	8.6	" A, BC	4	5.67	154.07	S.	H.	
2368	" "	9.4	λ Geminorum . .	4	4.25	154.30	P.	H.	
2369	" "	9.5	"	4	3.85	243.95	P.	H.	
2370	" "	9.5	"	4	3.87	243.62	S.	H.	
2371	" "	9.6	"	4	4.17	153.67	S.	H.	
2372	" "	9.7	ε Geminorum . .	4	3.07	153.67	P.	H.	
2373	" "	9.7	"	4	4.02	153.87	S.	H.	
2374	" "	9.8	"	4	3.47	244.22	P.	H.	
2375	" "	9.8	"	4	5.45	243.10	S.	H.	
2376	April 2	7.6	η Tauri	4	11.00	153.15	P.	H.	April 2. Seeing 5, 7, 3.
2377	" "	7.6	"	4	13.07	242.37	P.	H.	Images brighter than in last set.
2378	" "	7.8	ψ Cassiopeiæ A, BC	5	6.02	153.07	P.	H.	
2379	" "	7.8	" A, BC	4	5.72	243.27	P.	H.	
2380	" "	7.9	" A, B	4	4.50	243.65	U.	H.	B and C separated
2381	" "	8.0	" A, B	4	4.62	153.27	U.	H.	
2382	" "	8.0	" A, C	4	3.67	153.57	U.	H.	
2383	" "	8.1	" A, C	4	3.80	243.95	U.	H.	
2384	" "	8.3	" A, BC	4	6.65	243.90	S.	H.	Nos. 2384-2390 through clouds.
2385	" "	8.7	γ Leonis	4	28.30	156.70	S.	H.	
2386	" "	8.7	"	4	29.47	155.17	S.	H.	
2387	" "	8.7	"	4	27.97	155.67	U.	H.	
2388	" "	8.8	"	4	27.95	245.85	U.	H.	
2389	" "	9.2	δ Bootis	6	36.40	154.45	S.	H.	{ Two images of same component.
2390	" "	9.3	"	4	38.70	156.90	S.	H.	
2391	April 8	7.5	ν Ursæ Majoris .	4	4.42	151.67	U.	H.	April 8. Seeing 3, 3, 3.
2392	" "	7.6	" "	4	5.12	242.87	U.	H.	
2393	" "	7.7	" "	4	4.95	241.65	P.	H.	
2394	" "	7.8	" "	4	4.35	152.45	P.	H.	
2395	" "	8.2	Star, Uranus . . .	5	3.306		P.	I.	Pos. angle 210°. Oberon?
2396	" "	8.8	ε Bootis	4	15.15	157.85	S.	H.	Seeing very poor.
2397	" "	8.9	"	4	16.25	248.80	S.	H.	
2398	" "	9.0	θ Virginis A, B .	4	9.82	248.32	P.	H.	
2399	" "	9.0	" A, B	4	9.35	157.60	P.	H.	
2400	" "	9.1	" A, B	4	9.65	158.30	U.	H.	
Total Number . .				12458					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2401	April 8	9.1	θ Virginis A, B . .	4	9.80	247.25	U.	H.	
2402	" "	9.2	" " A, B . .	4	10.92	249.37	S.	H.	
2403	" "	9.3	" " A, B . .	4	9.27	158.72	S.	H.	
2404	" "	9.5	δ Bootis	4	4.75	243.15	S.	H.	
2405	" "	9.6	"	4	6.97	244.32	P.	H.	
2406	" "	9.6	"	4	6.77	154.32	P.	H.	
2407	" "	9.7	"	4	6.82	153.32	U.	H.	
2408	" "	9.8	"	4	8.45	242.25	U.	H.	
2409	" "	9.9	δ Corvi	4	4.25	153.15	P.	H.	
2410	" "	9.9	"	4	5.45	243.15	P.	H.	
2411	" "	10.0	"	4	5.57	243.37	U.	H.	
2412	" "	10.1	"	4	5.40	153.40	U.	H.	
2413	April 9	7.3	δ Orionis	4	8.02	152.97	P.	H.	April 9. Seeing 2, 4, 3.
2414	" "	7.3	"	4	6.92	242.57	P.	H.	
2415	" "	7.4	"	4	8.47	242.52	U.	H.	
2416	" "	7.4	"	4	6.77	152.97	U.	H.	
2417	April 13	8.6	δ Orionis	4	7.17	242.87	S.	H.	April 13. Seeing 2, 3, 4.
2418	" "	8.6	"	4	6.72	152.82	S.	H.	
2419	" "	9.1	ψ Cassiopeiæ A, BC	4	7.72	244.87	S.	H.	B and C not separated.
2420	" "	9.2	" " A, BC	4	5.97	154.67	S.	H.	BC less distinctly seen.
2421	April 14	8.9	ψ Cassiopeiæ A, BC	4	7.47	241.92	S.	H.	A above BC.
2422	" "	9.0	" " A, BC	4	5.17	151.62	S.	H.	A below BC.
2423	" "	9.1	" " A, B	4	4.15	151.50	S.	H.	A below BC.
2424	" "	9.2	" " A, B	4	6.17	241.57	S.	H.	A above BC.
2425	" "	9.3	" " A, B	4	4.37	241.12	S.	H.	A below BC.
2426	" "	9.4	" " A, B	4	5.57	151.07	S.	H.	A above BC.
2427	" "	10.1	4 H. Camelopardali	4	7.50	242.10	S.	H.	B barely visible.
2428	" "	10.2	"	4	6.87	151.77	S.	H.	April 14. Seeing 3, 6, 5.
2429	April 16	8.5	ι Cancri	4	18.55	151.35	S.	H.	April 16. Seeing 2, 5, 5.
2430	" "	8.5	"	4	17.32	240.62	S.	H.	
2431	" "	8.6	"	4	19.10	240.30	U.	H.	
2432	" "	8.7	"	4	19.30	149.20	U.	H.	
2433	" "	8.8	83 Leonis	4	32.30	149.55	S.	H.	Through clouds.
2434	" "	8.9	"	4	33.57	151.22	S.	H.	
2435	" "	9.0	"	4	31.82	148.62	U.	H.	
2436	" "	9.0	"	4	30.95	239.90	U.	H.	Scarcely visible.
2437	April 17	9.2	ι Leonis	4	18.30	246.75	S.	H.	April 17. Seeing 6, 4, 4.
2438	" "	9.3	"	4	16.57	156.12	S.	H.	Images farther apart.
2439	" "	9.6	κ Geminorum	4	4.10	240.75	S.	H.	
2440	" "	9.7	"	4	3.82	150.97	S.	H.	
2441	April 18	7.1	η Tauri	4	14.02	151.37	U.	H.	April 18. Seeing 8, 4, 3.
2442	" "	7.2	"	4	14.02	242.07	U.	H.	
2443	" "	7.6	ζ Orionis A, C . .	4	1.27	152.32	U.	H.	
2444	" "	7.8	" " A, C . .	4	1.47	242.22	U.	H.	
2445	" "	8.1	δ Orionis	4	8.27	241.67	U.	H.	
2446	" "	8.2	"	4	6.97	152.02	U.	H.	B seems fainter than before.
2447	" "	8.8	ε Geminorum	4	3.87	152.22	U.	H.	
2448	" "	8.8	"	4	3.82	242.52	U.	H.	
2449	" "	8.9	"	4	4.50	242.05	S.	H.	
2450	" "	8.9	"	4	4.92	152.77	S.	H.	
2451	" "	9.1	α Geminorum A, C	4	2.97	152.37	S.	H.	} A out of field.
2452	" "	9.1	" " A, C	4	2.45	242.45	S.	H.	
2453	" "	9.2	" " A, C	4	2.37	242.32	U.	H.	
2454	" "	9.3	" " A, C	4	2.37	152.27	U.	H.	
2455	" "	9.6	τ Leonis	4	14.35	152.30	U.	H.	
2456	" "	9.6	"	4	16.40	242.25	U.	H.	
2457	" "	9.7	"	4	12.70	241.10	S.	H.	
2458	" "	9.8	"	4	17.47	152.97	S.	H.	
2459	" "	10.1	α Leonis	4	5.17	241.77	U.	H.	
2460	" "	10.2	"	4	4.62	151.77	U.	H.	
Total Number . .				12698					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2461	April 18	10.8	23 <i>h</i> Ursæ Majoris	4	4.87	151.22	U.	H.	
2462	" "	10.8	" "	4	5.35	240.70	U.	H.	
2463	April 19	7.5	β Orionis	4	3.12	227.17	U.	H.	April 19. Seeing 5, 3, 3.
2464	" "	7.6	"	4	3.00	137.20	U.	H.	
2465	" "	7.7	δ Orionis	4	8.55	136.85	U.	H.	
2466	" "	7.8	"	4	7.75	227.40	U.	H.	
2467	April 21	7.5	β Orionis	4	3.22	226.72	P.	H.	April 21. Seeing 7, 5, 6.
2468	" "	7.6	"	4	3.47	137.57	P.	H.	Definition very poor.
2469	" "	7.9	88 Tauri	4	11.22	225.97	P.	H.	Clouds.
2470	" "	8.0	"	4	12.10	136.60	P.	H.	
2471	" "	8.2	"	4	14.25	136.10	S.	H.	A above B
2472	" "	8.3	"	5	8.20	226.95	S.	H.	A below B, faint, diffuse.
2473	" "	8.4	τ Tauri	4	11.80	227.15	P.	H.	
2474	" "	8.4	"	4	13.30	226.65	S.	H.	
2475	" "	8.5	"	4	17.07	137.82	P.	H.	
2476	" "	8.5	"	4	16.10	136.55	S.	H.	
2477	" "	8.7	4 H. Camelopardali	4	6.77	137.87	P.	H.	
2478	" "	8.7	"	4	7.07	138.42	S.	H.	Images 45°.
2479	" "	8.8	"	4	6.50	227.85	S.	H.	Images 225°.
2480	" "	8.9	"	4	6.27	228.17	P.	H.	
2481	" "	9.0	7 H. Camelopardali	4	3.92	227.62	P.	H.	
2482	" "	9.0	"	4	3.52	138.37	P.	H.	
2483	" "	9.1	"	4	3.40	137.85	S.	H.	
2484	" "	9.2	"	4	3.70	226.70	S.	H.	Almost invisible.
2485	" "	9.4	ϵ Geminorum . .	4	2.92	136.37	P.	H.	
2486	" "	9.4	"	4	3.92	135.82	S.	H.	A redder than B.
2487	" "	9.5	"	4	3.35	226.50	P.	H.	
2488	" "	9.5	"	4	3.55	226.05	S.	H.	
2489	" "	9.7	π Geminorum . .	4	4.10	137.50	P.	H.	
2490	" "	9.8	"	4	4.07	227.22	P.	H.	
2491	" "	9.8	"	4	4.42	227.32	S.	H.	
2492	" "	9.9	"	4	3.85	137.15	S.	H.	
2493	" "	10.0	α Geminorum A, C	4	2.02	226.82	P.	H.	
2494	" "	10.0	" A, C	4	2.27	136.77	P.	H.	
2495	April 24	8.1	ι Cancri	4	17.00	142.60	P.	H.	April 24. Seeing 2, 8, 8.
2496	" "	8.1	"	4	15.95	233.05	P.	H.	Colors marked, B blue.
2497	" "	8.2	"	4	18.25	233.55	U.	H.	Scarcely visible.
2498	" "	8.3	"	4	15.32	144.12	U.	H.	
2499	May 1	7.9	τ Tauri	4	13.52	229.67	S.	H.	May 1. Seeing bad.
2500	" "	7.9	"	4	15.47	139.72	S.	H.	
2501	" "	8.0	"	3	15.75	50.72	U.	H.	Clouds.
2502	" "	9.7	ζ Ursæ Majoris .	4	27.87	225.12	S.	H.	
2503	" "	9.7	" "	4	25.45	137.20	S.	H.	
2504	" "	9.8	" "	4	29.80	139.30	U.	H.	
2505	" "	9.9	" "	4	27.25	227.65	U.	H.	
2506	" "	10.1	23 <i>h</i> Ursæ Majoris	4	4.55	227.10	P.	H.	
2507	" "	10.2	" "	4	5.07	136.72	P.	H.	
2508	May 2	7.5	α Puppis	4	46.70	139.05	P.	H.	May 2. Seeing 7, 7, 5.
2509	" "	7.5	"	4	46.97	139.17	P.	H.	
2510	" "	7.6	"	4	41.05	227.25	U.	H.	
2511	" "	7.6	"	4	43.65	139.15	U.	H.	
2512	" "	7.9	τ Tauri	4	13.25	138.05	U.	H.	
2513	" "	7.9	"	4	15.10	226.35	U.	H.	
2514	" "	8.0	11 Monocerotis B, C	4	40.00	142.95	P.	H.	
2515	" "	8.1	" B, C	4	43.65	140.15	P.	H.	Difficult.
2516	" "	8.2	μ Canis Majoris .	4	23.12	233.17	P.	H.	
2517	" "	8.2	" "	4	19.92	141.17	P.	H.	B not seen afterwards.
2518	" "	8.3	" "	4	19.85	141.85	S.	H.	
2519	" "	8.6	2 H. Camelopardali	4	7.52	141.82	S.	H.	
2520	" "	8.6	"	4	8.45	232.05	S.	H.	Reversed images.
Total Number . .				12938					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2521	May 2	8.8	2 H. Camelopardali	4	10.67	231.52	P.	H.	
2522	" "	8.9	"	4	9.95	144.30	P.	H.	Reversed images, B more visible.
2523	" "	8.9	"	4	7.00	142.15	U.	H.	
2524	" "	9.0	"	4	7.67	232.47	U.	H.	Images not reversed.
2525	" "	9.3	δ Corvi	4	5.07	139.07	P.	H.	
2526	" "	9.4	"	4	4.67	228.87	P.	H.	
2527	" "	9.4	"	4	3.45	229.30	S.	H.	
2528	" "	9.5	"	4	5.65	139.25	S.	H.	
2529	" "	9.7	19 H. Camelopardali	4	9.85	138.85	P.	H.	
2530	" "	9.8	"	4	9.07	227.67	P.	H.	
2531	" "	9.8	"	4	9.67	227.47	U.	H.	
2532	" "	9.9	"	4	10.57	137.37	U.	H.	
2533	May 3	8.6	"	4	10.77	226.97	P.	H.	May 3. Seeing 6, 8, 7.
2534	" "	8.7	"	4	9.95	138.40	P.	H.	
2535	" "	8.7	"	4	10.82	138.32	U.	H.	
2536	" "	8.8	"	4	11.22	227.77	U.	H.	
2537	" "	9.1	32 H. Camelopardali	4	43.25	138.00	U.	H.	Seeing poor.
2538	" "	9.2	"	4	37.92	228.52	U.	H.	Definition improved.
2539	" "	9.2	"	4	35.22	228.32	P.	H.	
2540	" "	9.2	"	4	35.92	136.72	P.	H.	
2541	" "	9.4	38 Lyncis	4	26.70	141.25	P.	H.	B reddish.
2542	" "	9.5	"	4	22.92	230.47	P.	H.	Seeing good.
2543	" "	9.6	"	4	24.30	233.85	U.	H.	Seeing poor, images blurred.
2544	" "	9.7	"	4	22.50	142.55	U.	H.	
2545	" "	9.8	ξ Ursæ Majoris .	4	37.60	143.15	U.	H.	
2546	" "	9.9	" " .	4	38.92	231.32	U.	H.	
2547	" "	10.0	" " .	4	37.97	230.22	P.	H.	
2548	" "	10.1	" " .	4	42.90	143.95	P.	H.	Seeing poor.
2549	May 4	7.9	12 Canum Venat.	4	14.82	138.27	P.	H.	May 4. Seeing variable
2550	" "	8.0	" "	4	17.97	229.37	P.	H.	
2551	" "	8.1	" "	4	15.37	228.92	S.	H.	
2552	" "	8.2	" "	4	15.90	138.35	S.	H.	
2553	" "	8.3	93 Leonis	4	8.67	228.82	P.	H.	
2554	" "	8.3	"	4	8.15	228.10	S.	H.	
2555	" "	8.4	"	4	6.25	137.85	P.	H.	
2556	" "	8.5	"	4	8.32	137.77	S.	H.	
2557	May 6	7.7	π Puppis	4	45.05	143.65	P.	H.	
2558	" "	7.7	"	4	47.35	142.25	P.	H.	
2559	" "	7.8	"	4	42.87	142.17	U.	H.	
2560	" "	7.8	"	4	42.72	141.67	U.	H.	
2561	" "	8.1	π Geminorum . .	4	3.70	227.50	U.	H.	Scarcely visible at times.
2562	" "	8.2	"	4	4.45	137.50	U.	H.	Clouds.
2563	" "	8.5	"	4	5.27	137.37	P.	H.	
2564	" "	8.5	"	4	3.97	226.72	P.	H.	
2565	" "	8.8	π Geminorum . .	4	3.55	225.40	U.	H.	
2566	" "	8.8	"	4	3.62	134.97	U.	H.	Seen with difficulty.
2567	" "	9.0	"	4	4.42	135.22	P.	H.	
2568	" "	9.0	"	4	4.17	225.47	P.	H.	
2569	" "	9.2	7 H. Camelopardali	4	2.92	225.07	P.	H.	
2570	" "	9.3	"	4	3.10	134.70	P.	H.	
2571	May 7	7.5	μ Canis Majoris .	4	15.77	229.12	U.	H.	May 7. Seeing 8, 8, 7.
2572	" "	7.6	" " .	4	18.62	227.47	P.	H.	
2573	" "	7.6	" " .	4	20.30	139.35	P.	H.	
2574	" "	7.7	" " .	5	16.47	138.57	U.	H.	
2575	" "	8.3	α Canis Minoris .	5	.794		P.	I.	
2576	" "	8.3	" " .	5	.730		U.	I.	
2577	" "	8.4	β Canis Minoris B .	5	1.462		U.	I.	
2578	" "	8.8	" " C .	5	1.382		U.	I.	
2579	" "	8.9	" " D .	5	1.392		U.	I.	
2580	" "	9.0	" " D .	5	1.202		S.	I.	
Total Number . .				13185					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2581	May 7	9.1	β Canis Minoris c .	5	1.560		S.	I.	
2582	" "	9.2	" " B .	5	1.610		S.	I.	
2583	" "	9.8	Oberon, Uranus .	5	2.134		S.	I.	
2584	" "	10.0	" " .	5	1.890		U.	I.	
2585	" "	10.2	" " .	5	2.528		P.	I.	
2586	" "	8.9	α Leonis	4	1.87	226.82	P.	(H.)	20°, 10".
2587	" "	9.0	" "	4	2.07	136.87	P.	(H.)	
2588	" "	9.1	ϵ , 5 Lyræ	4	48.00	139.45	P.	(H.)	
2589	" "	9.2	" "	4	46.05	140.30	P.	(H.)	
2590	" "	9.3	ζ Lyræ	4	26.45	228.90	P.	(H.)	
2591	" "	9.4	" "	4	27.65	139.55	P.	(H.)	
2592	" "	9.9	α Libræ	4	18.20	227.25	P.	(H.)	
2593	" "	9.9	" "	4	17.92	136.77	P.	(H.)	Images too near.
2594	May 8	9.0	93 Leonis	4	8.62	137.02	U.	H.	May 8. Seeing 6, 3, 3.
2595	" "	9.1	" "	4	7.47	226.62	U.	H.	
2596	" "	9.3	δ Corvi	4	4.95	227.50	U.	H.	
2597	" "	9.4	" "	4	5.02	137.87	U.	H.	
2598	" "	9.7	γ Virginis	4	45.38	139.62	U.	H.	
2599	" "	9.8	" "	4	46.78	137.12	U.	H.	
2600	" "	9.9	" "	4	43.28	227.42	P.	H.	
2601	" "	10.0	" "	4	48.18	139.77	P.	H.	
2602	May 10	8.1	α Leonis	4	3.55	227.10	P.	H.	May 10. Seeing 6, 4, 2.
2603	" "	8.1	" "	4	3.30	136.20	P.	H.	
2604	" "	8.2	" "	4	4.17	136.37	U.	H.	
2605	" "	8.2	" "	4	4.57	226.37	U.	H.	
2606	" "	8.5	α Canis Minoris .	5	.684		P.	I.	
2607	" "	8.6	" "	5	.720		U.	I.	
2608	" "	8.7	β Canis Minoris B .	6	2.095		P.	I.	Pencil partly lost. (?)
2609	" "	8.8	" " D .	5	1.540		P.	I.	
2610	" "	8.9	" " D .	5	1.122		U.	I.	
2611	" "	9.0	" " B .	5	1.268		U.	I.	Image blurred.
2612	" "	9.1	" " C .	5	1.202		U.	I.	
2613	" "	9.3	" " C .	5	1.782		P.	I.	
2614	" "	9.4	α Geminorum c .	5	2.890		P.	I.	C reddish. Image large.
2615	" "	9.5	δ Cancri	5	2.328		P.	I.	
2616	" "	9.6	" "	5	2.136		U.	I.	
2617	" "	9.9	ϵ Virginis	5	.842		U.	I.	
2618	" "	9.9	" "	5	.904		P.	I.	
2619	" "	8.9	α Leonis	4	2.65	226.60	S.	(H.)	
2620	" "	9.4	" "	4	2.45	140.65	S.	(H.)	
2621	" "	9.6	ζ Leonis	4	23.72	143.62	S.	(H.)	} A out of field.
2622	" "	9.7	" "	4	23.02	227.12	S.	(H.)	
2623	May 11	8.5	α Geminorum . .	4	4.72	137.52	P.	H.	May 11. Seeing 6, 7, 6.
2624	" "	8.6	" "	4	4.20	138.20	S.	H.	
2625	" "	8.6	" "	4	3.65	228.95	P.	H.	
2626	" "	8.7	" "	4	3.87	228.27	S.	H.	B seen at long intervals.
2627	" "	9.0	38 Lynceis	4	25.07	230.92	S.	H.	
2628	" "	9.2	" "	4	21.45	138.50	S.	H.	Seeing better than for last set.
2629	" "	9.2	" "	4	25.62	139.62	P.	H.	
2630	" "	9.4	" "	4	22.15	230.50	P.	H.	
2631	May 12	8.9	38 Lynceis	4	22.40	135.85	P.	H.	May 12. Seeing 6, 5, 5.
2632	" "	9.0	" "	4	20.70	135.20	S.	H.	
2633	" "	9.1	" "	5	23.47	225.67	P.	H.	
2634	" "	9.2	" "	4	20.45	224.65	S.	H.	
2635	" "	9.4	γ Virginis	4	49.33	226.97	P.	H.	
2636	" "	9.5	" "	4	43.05	226.00	S.	H.	Clouds.
2637	" "	9.7	" "	4	43.38	143.42	S.	H.	
2638	" "	9.8	" "	4	43.22	230.37	P.	H.	
2639	May 13	8.0	σ^2 Ursæ Majoris .	4	10.25	142.35	U.	H.	May 13. Seeing 7, 4, 5.
2640	" "	8.2	" "	4	9.45	232.65	U.	H.	
Total Number				13445					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2641	May 13	8.4	23 <i>h</i> Ursæ Majoris	4	5.02	141.72	S.	H.	
2642	" "	8.5	" "	4	5.30	231.75	S.	H.	
2643	" "	8.6	" "	4	4.95	232.00	U.	H.	
2644	" "	8.6	" "	4	4.72	141.57	U.	H.	
2645	" "	8.8	<i>ι</i> Ursæ Majoris	4	2.37	141.37	U.	H.	
2646	" "	8.8	" "	4	2.10	231.50	U.	H.	
2647	" "	9.6	32 H. Camelopardali	4	38.80	226.10	S.	H.	
2648	" "	9.7	" "	4	35.72	137.77	S.	H.	
2649	" "	9.8	" "	4	38.32	136.07	U.	H.	
2650	" "	9.9	" "	4	38.47	228.72	U.	H.	
2651	" "	10.1	ψ Draconis . . .	4	32.55	136.30	S.	H.	
2652	" "	10.1	" . . .	4	30.52	227.67	S.	H.	
2653	" "	10.2	" . . .	4	32.85	226.10	U.	H.	
2654	" "	10.3	" . . .	4	29.12	137.67	U.	H.	
2655	May 14	9.1	ξ Bootis . . .	4	22.87	140.07	P.	H.	
2656	" "	9.2	" . . .	4	20.30	228.15	P.	H.	
2657	" "	9.2	" . . .	4	21.77	227.07	S.	H.	
2658	" "	9.3	" . . .	4	22.47	139.52	S.	H.	
2659	May 17	8.5	γ Virginis . . .	4	45.72	140.47	U.	H.	
2660	" "	8.6	" . . .	4	45.55	143.10	U.	H.	Clouds.
2661	" "	8.7	" . . .	4	47.00	142.75	S.	H.	
2662	" "	8.8	" . . .	4	43.67	142.92	S.	H.	Without driving-clock
2663	" "	9.3	μ Herculis . . .	4	4.25	140.60	P.	H.	
2664	" "	9.3	" . . .	4	5.05	230.70	P.	H.	
2665	" "	9.5	ν Draconis . . .	4	48.43	139.42	S.	H.	
2666	" "	9.5	" . . .	4	48.35	137.15	S.	H.	
2667	May 18	8.3	α Geminorum C .	5	3.938		P.	I.	C redder than A.
2668	" "	8.4	" C .	5	3.430		S.	I.	A perhaps most in cloud.
2669	" "	8.6	α Leonis . . .	4	4.17	137.92	P.	H.	
2670	" "	8.6	" . . .	4	5.07	138.67	S.	H.	
2671	" "	8.7	" . . .	4	5.47	228.42	S.	H.	
2672	" "	8.7	" . . .	4	3.85	228.65	P.	H.	
2673	" "	9.2	θ Virginis A, B .	4	10.80	227.27	S.	H.	Driving-clock troublesome.
2674	" "	9.3	" A, B .	4	9.70	137.20	S.	H.	
2675	" "	9.3	" A, B .	4	9.80	136.95	P.	H.	
2676	" "	9.3	" A, B .	4	9.37	226.52	P.	H.	C seems brighter than B.
2677	" "	9.4	" A, C .	4	3.10	227.10	P.	H.	
2678	" "	9.4	" A, C .	4	2.92	136.72	P.	H.	
2679	" "	9.5	" A, C .	4	2.67	137.22	S.	H.	Seen with difficulty.
2680	" "	9.7	" A, C .	4	2.97	227.52	S.	H.	C seems brighter than B.
2681	May 19	8.4	93 Leonis . . .	4	8.17	137.22	S.	H.	At intervals, thro' clouds May 19. Seeing 5, 4, 5.
2682	" "	8.4	" . . .	4	7.32	138.07	P.	H.	
2683	" "	8.5	" . . .	4	7.47	227.32	S.	H.	
2684	" "	8.6	" . . .	4	8.37	227.52	P.	H.	
2685	" "	8.9	24 Comæ Berenices	4	26.95	225.95	P.	H.	
2686	" "	9.0	" "	4	23.97	225.87	S.	H.	
2687	" "	9.1	" "	4	24.90	135.95	P.	H.	
2688	" "	9.1	" "	4	25.05	135.55	S.	H.	
2689	" "	9.3	35 Comæ Ber. AB, C	4	6.85	226.25	P.	H.	
2690	" "	9.4	" " AB, C	4	6.70	226.95	S.	H.	
2691	" "	9.4	" " AB, C	4	5.30	136.45	P.	H.	
2692	" "	9.5	" " AB, C	4	7.70	136.10	S.	H.	
2693	" "	9.8	23 <i>h</i> Ursæ Majoris	4	4.57	226.07	P.	H.	
2694	" "	9.9	" "	4	5.60	135.75	P.	H.	
2695	May 21	9.5	π Bootis . . .	4	30.05	139.10	S.	H.	Images 45°, clouds.
2696	" "	9.5	" . . .	4	36.45	228.35	S.	H.	
2697	" "	9.6	" . . .	4	32.50	229.05	U.	H.	Clearer. [tant, clouds.
2698	" "	9.7	" . . .	4	33.75	138.95	U.	H.	May 21. Seeing 6, 3, 4.
2699	" "	9.8	ε Bootis . . .	4	18.47	230.07	U.	H.	
2700	May 22	7.9	24 Comæ Berenices	4	22.75	136.85	P.	H.	
Total Number . .				13687					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2701	May 22	7.9	24 Comæ Berenices	4	22.92	228.37	P.	H.	
2702	" "	8.0	" "	4	24.12	228.02	U.	H.	
2703	" "	8.0	" "	4	25.22	138.27	U.	H.	
2704	" "	8.5	Distant Lamp . .	5	3.768		P.	[I.]	For constant.
2705	" "	8.5	" " . .	5	3.590		U.	[I.]	Images brought closer.
2706	" "	8.7	" " . .	5	4.204		S.	[I.]	Brought closer still.
2707	May 25	8.6	π Bootis	4	30.62	233.32	P.	H.	Images 45°.
2708	" "	8.7	" "	4	33.02	233.12	S.	H.	May 25. Seeing 5, 6, 2.
2709	" "	8.8	" "	4	35.40	139.40	S.	H.	Images 225°, perhaps more distant.
2710	" "	8.8	" "	4	36.20	140.60	P.	H.	
2711	" "	8.9	δ Bootis	4	5.05	137.05	P.	H.	Clouds passing.
2712	" "	9.0	" "	4	4.80	137.70	S.	H.	
2713	" "	9.1	" "	4	5.92	227.52	P.	H.	
2714	" "	9.1	" "	4	5.87	227.42	S.	H.	
2715	" "	9.3	35 Comæ Ber. AB, C	4	4.50	136.85	P.	H.	Images 180°.
2716	" "	9.3	" " AB, C	4	4.77	136.47	S.	H.	Variable haze.
2717	" "	9.4	" " AB, C	4	6.87	226.42	P.	H.	Images 0°.
2718	" "	9.4	" " AB, C	4	9.02	226.67	S.	H.	C more easily seen.
2719	" "	9.7	θ Virginis A, B . .	4	10.65	138.60	P.	H.	Images 270°, C appar-
2720	" "	9.8	" " A, B . .	4	10.82	229.42	P.	H.	Images 90°, [ently] > B.
2721	" "	9.8	" " A, C . .	4	3.15	226.45	P.	H.	Images 180°, A out of field.
2722	" "	9.9	" " A, C . .	4	3.22	136.12	P.	H.	0°. A out of field.
2723	" "	9.9	" " A, C . .	4	3.37	136.07	S.	H.	C looks > B if A is in field.
2724	" "	10.0	" " A, C . .	4	3.20	226.85	S.	H.	
2725	May 26	8.1	ξ Bootis	4	22.00	140.70	P.	H.	270°, 5". May 26. See-
2726	" "	8.1	" "	4	21.37	140.52	S.	H.	ing 5, 4, 4.
2727	" "	8.2	" "	4	18.82	230.07	P.	H.	340°, 5".
2728	" "	8.3	" "	4	21.00	229.95	S.	H.	
2729	" "	8.4	β Serpentis	4	3.00	225.75	P.	H.	30°, 10".
2730	" "	8.5	" "	4	3.10	136.05	P.	H.	240°, 10".
2731	" "	8.5	" "	4	2.97	135.77	S.	H.	250°, 12".
2732	" "	8.6	" "	4	4.35	225.75	S.	H.	40°, 8".
2733	" "	8.8	δ Herculis	4	3.87	226.52	P.	H.	150°, 10".
2734	" "	8.9	" "	4	4.20	136.40	P.	H.	{ 320°, 10".
2735	" "	8.9	" "	4	5.20	136.70	S.	H.	
2736	" "	9.0	" "	4	4.15	226.35	S.	H.	170°, 10".
2737	" "	9.2	μ Herculis	4	3.32	225.62	P.	H.	20°, 10".
2738	" "	9.2	" "	4	2.77	135.12	P.	H.	230°, 10".
2739	" "	9.3	" "	4	2.87	135.52	S.	H.	240°, 10".
2740	" "	9.5	" "	4	3.40	225.50	S.	H.	20°, 10".
2741	" "	9.7	ν Draconis	4	43.97	135.92	P.	H.	300°, 10".
2742	" "	9.8	" "	4	45.90	137.40	S.	H.	300°, 8".
2743	" "	9.9	" "	4	43.95	224.80	S.	H.	140°, 8".
2744	" "	10.0	" "	4	45.45	135.10	P.	H.	
2745	May 27	8.6	Distant Lamp . .	5	2.886		S.	[I.]	For constant.
2746	" "	9.0	α Geminorum c .	5	2.846		S.	I.	May 27. Seeing 8, 7, 6.
2747	" "	9.1	" " c .	5	3.202		P.	I.	C reddish.
2748	" "	9	α Leonis	4	1.95	140.90	U.	(H.)	
2749	" "	9	" "	4	3.22	230.02	U.	(H.)	
2750	" "	9.6	ζ Leonis	4	2.12	227.07	U.	(H.)	{ Probably two images of same component.
2751	" "	9.7	" "	4	1.90	137.00	U.	(H.)	
2752	May 28	8.7	α Geminorum c .	5	2.492		U.	I.	C ruddy.
2753	" "	8.8	" " c .	5	2.872		S.	I.	May 28. Seeing 6, 5, 2.
2754	May 29	8.8	ν Draconis	4	46.00	140.90	S.	H.	120°, 5". May 29. See-
2755	" "	9.0	" "	4	45.82	140.07	S.	H.	[ing 3, 3, 3.
2756	" "	9.2	" "	4	41.27	137.67	U.	H.	{ 130°, 5".
2757	" "	9.2	" "	4	43.95	137.80	U.	H.	
2758	" "	9.7	ρ Herculis	4	35.57	139.12	U.	H.	315°, 4".
2759	" "	9.7	" "	4	35.92	228.02	U.	H.	80°, 4".
2760	" "	9.8	" "	4	35.35	226.55	S.	H.	95°, 4".
Total Number . .				13935					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2761	May 29	9.9	ϵ Herculis . . .	4	36.30	139.70	S.	H.	320°, 3".
2762	June 1	9.4	β Serpentis . . .	4	3.05	226.25	P.	H.	30°, 5". June 1. Seeing [7, 4, 6.
2763	" "	9.4	" . . .	4	3.20	135.80	P.	H.	210°, 5".
2764	" "	9.6	δ Serpentis . . .	4	34.72	137.72	P.	H.	160°, 4".
2765	" "	9.6	" . . .	4	32.52	229.07	P.	H.	280°, 4".
2766	" "	9.8	α Herculis . . .	4	30.22	135.07	P.	H.	150°, 5".
2767	" "	9.9	" . . .	4	31.57	226.77	P.	H.	290°, 5".
2768	June 3	7.8	Sky . . .	39			P.	I.	For const. Var. aperts.
2769	" "	8.3	Distant Lamp . .	6	3.632		P.	[I.]	For constant.
2770	" "	8.3	ϵ Bootis . . .	4	20.75	142.80	S.	H.	80°, 3".
2771	" "	8.5	" . . .	4	22.05	144.75	P.	H.	June 3. Seeing 6, 6, 6.
2772	" "	8.5	" . . .	4	20.47	230.42	S.	H.	320°, 3".
2773	" "	8.6	" . . .	4	18.00	232.00	P.	H.	
2774	" "	8.6	Distant Lamp . .	5	3.460		U.	[I.]	For constant.
2775	" "	8.8	ξ Ursæ Majoris .	4	43.97	139.92	S.	H.	300°, 2".
2776	" "	8.9	" " . . .	4	35.67	143.07	S.	H.	100°, 2". Seeing better.
2777	" "	9.2	ν Ursæ Majoris .	4	3.52	231.57	P.	H.	160°, 3".
2778	" "	9.2	" " . . .	4	4.27	141.67	P.	H.	20°, 3".
2779	" "	9.3	" " . . .	4	3.67	141.42	S.	H.	10°, 2".
2780	" "	9.4	" " . . .	4	3.27	231.77	S.	H.	170°, 2".
2781	June 4	9.0	ξ Ursæ Majoris .	4	36.00	140.60	U.	H.	300°, 3". June 4. See-
2782	" "	9.1	" " . . .	4	37.67	231.02	U.	H.	170°, 3". [ing 5, 6, 7.
2783	" "	9.2	" " . . .	4	40.45	230.60	S.	H.	185°, 3".
2784	" "	9.4	" " . . .	4	40.62	139.57	S.	H.	290°, 3".
2785	June 5	7.7	Sky . . .	39			U.	I.	For const. Var. aperts.
2786	" "	8.1	ϵ Bootis . . .	4	17.30	143.75	U.	H.	100°, 3". June 5. See-
2787	" "	8.2	" . . .	4	17.02	232.97	U.	H.	320°, 3". [ing 6, 6, 7.
2788	" "	8.3	" . . .	4	17.97	143.42	P.	H.	110°, 2".
2789	" "	8.4	" . . .	4	16.25	234.85	P.	H.	320°, 3".
2790	" "	8.5	ζ Coronæ . . .	4	34.10	142.75	P.	H.	90°, 3".
2791	" "	8.5	" . . .	4	34.90	234.25	P.	H.	300°, 2".
2792	" "	8.5	Distant Lamp . .	5	3.376		S.	[I.]	For constant.
2793	" "	8.5	ζ Coronæ . . .	4	32.32	233.62	U.	H.	290°, 3".
2794	" "	8.6	Distant Lamp . .	5	3.156		P.	[I.]	For constant.
2795	" "	8.6	ζ Coronæ . . .	5	28.97	146.52	U.	H.	110°, 3".
2796	" "	8.7	Distant Lamp . .	5	4.552		U.	[I.]	For constant.
2797	" "	8.8	δ Serpentis . . .	4	32.65	234.65	S.	H.	280°, 3".
2798	" "	8.9	" . . .	4	38.15	144.85	S.	H.	175°, 3". Images seem
2799	" "	9.0	" . . .	4	32.07	146.87	U.	H.	nearer.
2800	" "	9.1	" . . .	4	34.65	233.40	U.	H.	
2801	" "	9.9	δ Leonis . . .	5	1.266		U.	I.	
2802	" "	10.0	" . . .	2	1.210		S.	I.	
2803	" "	9.5	α Leonis . . .	4	2.30	236.55	P.	(H.)	170°, 15".
2804	" "	9.6	" . . .	4	2.12	236.32	P.	(H.)	A out of field.
2805	" "	9.6	" . . .	4	2.42	146.52	P.	(H.)	350°, 15".
2806	" "	9.7	" . . .	4	2.02	146.52	P.	(H.)	A out of field.
2807	" "	9.9	ζ Leonis . . .	4	22.65	143.00	P.	(H.)	
2808	June 6	7.9	π Bootis . . .	4	31.30	231.60	P.	H.	70°, 5". June 6. Seeing
2809	" "	7.9	" . . .	4	33.75	141.30	P.	H.	230°, 5". [7, 7, 7.
2810	" "	8.1	δ Bootis . . .	4	7.05	136.50	P.	H.	150°, 30".
2811	" "	8.2	" . . .	4	7.67	226.77	P.	H.	Last setting doubtful.
2812	" "	8.4	ν Draconis . . .	4	45.35	225.30	P.	H.	110°, 5".
2813	" "	8.4	" . . .	4	47.85	138.35	P.	H.	300°, 5".
2814	" "	8.5	μ Draconis . . .	4	41.32	140.22	P.	H.	300°, 3".
2815	" "	8.5	" . . .	4	44.17	141.27	S.	H.	310°, 3".
2816	" "	8.8	" . . .	4	46.58	232.27	P.	H.	190°, 3". 43.42 (?).
2817	" "	8.8	" . . .	4	42.72	141.37	S.	H.	175°, 3". 47.28 (?).
2818	" "	9.7	ι Ursæ Majoris .	5	3.118		P.	I.	
2819	" "	9.8	" " . . .	6	3.485		S.	I.	
2820	June 7	7.5	Sky . . .	39			P.	I.	For const. Var. aperts.
Total Number . .				14289					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2821	June 7	9.3	δ Serpentis . . .	4	31.75	144.85	P.	H.	150°, 3". Clouds passing.
2822	" "	9.4	" . . .	4	31.27	236.22	P.	H.	{ 320°, 3". June 7. Seeing
2823	" "	9.4	" . . .	4	30.10	236.40	S.	H.	{ 3, 6, 7.
2824	" "	10.0	" . . .	4	33.67	146.72	S.	H.	290°, 3". Too far apart.
2825	June 9	8.8	δ Leonis . . .	5	1.416		P.	I.	170°, 3". Reset images.
2826	" "	8.8	" . . .	5	1.208		S.	I.	Twilight strong. [2, 7, 4.
2827	" "	9.1	δ Cancr.	5	2.924		P.	I.	June 9. Seeing 7, 8, 8, to
2828	" "	9.1	"	5	2.414		S.	I.	Companion just visible.
2829	" "	9.5	ι Ursæ Majoris . .	5	3.986		P.	I.	
2830	" "	9.6	"	7	3.187		S.	I.	A partly in field.
2831	" "	10.0	ν Scorpii Δ , BC . .	4	21.67	136.72	P.	H.	{ 90°, 5".
2832	" "	10.0	" Δ , BC	4	18.02	137.67	S.	H.	
2833	" "	10.1	" Δ , BC	5	18.75	227.30	P.	H.	
2834	" "	10.2	" Δ , BC	4	18.87	228.57	S.	H.	260°, 5".
2835	" "	10.6	β Scorpii	4	21.47	228.12	P.	H.	100°, 3".
2836	" "	10.7	"	4	19.80	138.70	P.	H.	{ 300°, 5".
2837	" "	10.8	"	4	21.75	138.20	S.	H.	
2838	" "	10.9	"	4	20.12	228.12	S.	H.	95°, 5".
2839	" "	13.0	ι Bootis	4	10.90	230.00	P.	H.	60°, 15". Stars dim.
2840	" "	13.1	"	4	11.72	139.27	P.	H.	{ 240°, 10".
2841	" "	13.2	"	4	10.35	138.80	S.	H.	
2842	" "	13.2	"	4	13.27	226.27	S.	H.	40°, 10".
2843	" "	13.4	κ Bootis	4	19.57	137.87	P.	H.	250°, 10".
2844	" "	13.6	"	4	22.02	230.07	P.	H.	{ 100°, 10".
2845	" "	13.7	"	4	16.35	230.70	S.	H.	
2846	" "	13.7	"	4	21.52	141.42	S.	H.	250°, 10".
2847	June 12	9.1	σ^2 Ursæ Majoris .	4	15.15	139.20	S.	H.	240°, 3". June 12. See-
2848	" "	9.2	"	4	13.17	229.92	S.	H.	{ 135°, 3". [ing 7, 5, 6.
2849	" "	9.4	"	4	10.20	230.15	U.	H.	130°, 4".
2850	" "	9.5	"	4	10.40	139.85	U.	H.	230°, 3".
2851	" "	9.8	ι Ursæ Majoris .	4	1.95	142.55	U.	H.	260°, 4".
2852	" "	9.9	"	4	2.45	231.90	U.	H.	20°, 4".
2853	June 13	7.3	Sky	39			P.	I.	{ For constant. Various
2854	" "	7.6	"	39			U.	I.	{ apertures.
2855	" "	8.5	Distant Lamp . .	5	3.340		P.	I.	
2856	" "	8.5	"	5	3.746		U.	I.	{ For constant.
2857	" "	8.7	"	5	3.326		S.	I.	
2858	" "	9.9	ι Ursæ Majoris .	5	4.188		P.	I.	June 13. Seeing 4, 5, 6.
2859	" "	10.1	δ Leonis	5	1.942		P.	I.	
2860	" "	9.7	α Leonis	4	2.72	227.22	S.	(H.)	340°, 10".
2861	" "	9.9	"	4	1.72	138.37	S.	(H.)	175°, 10".
2862	" "	10.0	"	4	1.55	138.50	U.	(H.)	170°, 10".
2863	" "	10.1	"	4	3.02	228.67	U.	(H.)	310°, 12".
2864	" "	10.3	ζ Leonis	4	23.47	225.97	S.	(H.)	290°, 30".
2865	" "	10.4	"	4	21.62	217.60	S.	(H.)	290°, 30". Betw. clouds.
2866	June 14	8.4	ξ Bootis	4	18.68	140.27	U.	H.	240°, 3". Jn. 14. Seeing
2867	" "	8.4	"	4	24.27	228.62	U.	H.	{ 5°, 4". Focus poor. [5, 5, 5.
2868	" "	8.6	5 Serpentis . . .	4	5.82	228.72	U.	H.	110°, 5".
2869	" "	8.6	"	4	7.40	139.15	U.	H.	340°, 5".
2870	" "	8.7	"	4	7.22	138.25	S.	H.	350°, 5".
2871	" "	8.8	"	4	5.95	228.45	S.	H.	120°, 5".
2872	" "	9.0	β Serpentis . . .	4	2.55	227.55	S.	H.	200°, 4".
2873	" "	9.2	"	4	3.65	137.75	S.	H.	20°, 4".
2874	" "	9.6	α Serpentis . . .	5	1.900		S.	I.	
2875	" "	9.8	"	5	2.950		U.	I.	
2876	" "	10.1	α Virginis . . .	5	.600		P.	I.	
2877	" "	10.1	"	5	.466		S.	I.	
2878	" "	9.4	ζ Leonis	6	16.23	259.40	P.	(H.)	{ Images in line.
2879	" "	9.5	"	4	21.72	137.27	P.	(H.)	
2880	" "	9.6	"	4	18.62	139.12	P.	(H.)	
Total Number . . .				14619					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2881	June 14	9.7	17 Comæ Berenices	6	23.22	139.02	P.	(H.)	
2882	" "	9.8	" "	4	27.40	224.10	P.	(H.)	
2883	" "	9.9	" "	4	35.98	226.88	U.	(H.)	280°, 10". } A at times
2884	" "	10.0	" "	4	24.38	135.82	U.	(H.)	100°, 12". } not in focus.
2885	June 15	6.2	Sky . . .	39			S.	I.	For const. Var. aperts.
2886	" "	8.2	α Herculis . . .	4	16.92	228.08	P.	H.	80°, 5". June 15. See-
2887	" "	8.2	" . . .	4	17.37	227.57	S.	H.	85°, 5". [ing 5, 4, 3.
2888	" "	8.3	" . . .	4	20.95	137.70	P.	H.	240°, 5".
2889	" "	8.3	" . . .	4	19.75	136.35	S.	H.	230°, 5".
2890	" "	8.6	δ Herculis . . .	4	5.58	136.52	S.	H.	310°, 6".
2891	" "	8.7	" . . .	4	4.78	136.38	P.	H.	300°, 8".
2892	" "	8.7	" . . .	4	4.45	228.15	S.	H.	150°, 7".
2893	" "	8.8	" . . .	4	4.15	228.15	P.	H.	
2894	" "	9.0	π Herculis . . .	4	30.73	135.62	P.	H.	330°, 5".
2895	" "	9.1	" . . .	4	32.22	135.58	S.	H.	315°, 5".
2896	" "	9.2	" . . .	4	29.15	226.45	P.	H.	{ 130°, 5".
2897	" "	9.2	" . . .	4	27.70	225.60	S.	H.	
2898	" "	9.3	43 Herculis . . .	4	10.70	139.10	P.	H.	260°, 12".
2899	" "	9.4	" . . .	4	9.27	138.78	S.	H.	260°, 10".
2900	" "	9.4	" . . .	4	10.45	229.20	P.	H.	260°, 12".
2901	" "	9.5	" . . .	4	9.72	229.17	S.	H.	260°, 10".
2902	" "	9.6	σ Scorpii . . .	4	4.37	229.87	P.	H.	10°, 10". Seeing poor.
2903	" "	9.7	" . . .	4	4.30	140.00	P.	H.	210°, 10".
2904	" "	9.7	" . . .	4	3.70	139.60	S.	H.	200°, 10".
2905	" "	9.8	" . . .	4	6.15	230.05	S.	H.	0°, 10".
2906	" "	9.9	39 Ophiuchi . . .	4	25.12	229.47	P.	H.	90°, 10".
2907	" "	10.0	" . . .	4	25.15	138.95	P.	H.	290°, 10".
2908	" "	10.0	" . . .	4	25.40	140.10	S.	H.	300°, 10".
2909	" "	10.1	" . . .	4	26.45	230.70	S.	H.	90°, 10".
2910	June 16	8.2	ρ Herculis . . .	4	33.57	231.93	P.	H.	330°, 3".
2911	" "	8.2	" . . .	4	34.90	141.15	P.	H.	100°, 3".
2912	" "	8.3	" . . .	4	33.67	140.77	S.	H.	85°, 3".
2913	" "	8.4	" . . .	4	35.02	232.38	S.	H.	330°, 3".
2914	" "	8.6	17 Draconis A, C .	4	33.35	140.65	P.	H.	160°, 3".
2915	" "	8.6	" A, C .	4	31.42	140.57	S.	H.	130°, 3". Clouds.
2916	" "	8.6	" A, C .	4	34.45	231.05	P.	H.	{ 280°, 3".
2917	" "	8.6	" A, C .	4	36.30	230.75	S.	H.	
2918	" "	8.7	" A, B .	4	44.70	137.25	S.	H.	{ Image of A elongated.
2919	" "	8.8	" A, B .	4	46.00	138.80	P.	H.	{ 300°, 12".
2920	" "	8.9	" A, B .	4	42.90	137.60	S.	H.	{ Image of B elongated.
2921	" "	9.0	" A, B .	4	44.80	139.95	P.	H.	Clouds passing.
2922	June 18	8.9	ζ Coronæ . . .	4	34.50	137.30	S.	H.	330°, 4".
2923	" "	9.0	" . . .	4	33.48	226.42	S.	H.	{ 95°, 4".
2924	" "	9.0	" . . .	4	35.30	229.15	U.	H.	
2925	" "	9.1	" . . .	4	35.82	139.52	U.	H.	300°, 5".
2926	" "	9.4	α Herculis . . .	4	22.20	229.75	S.	H.	95°, 3".
2927	" "	9.5	" . . .	4	21.00	137.50	S.	H.	260°, 3". Often lost in
2928	" "	9.6	" . . .	4	18.40	137.65	U.	H.	210°, 5". [clouds.
2929	" "	9.7	" . . .	4	21.95	227.75	U.	H.	85°, 4".
2930	" "	9.9	δ Herculis . . .	4	6.02	226.67	U.	H.	290°, 5". Plainly seen.
2931	" "	10.0	" . . .	4	4.40	137.10	U.	H.	160°, 5".
2932	June 19	8.0	α Herculis . . .	4	16.77	144.03	P.	H.	90°, 4".
2933	" "	8.1	" . . .	4	21.97	234.87	P.	H.	250°, 3".
2934	" "	8.5	ν Serpentis . . .	4	6.12	141.87	P.	H.	130°, 10". B faint.
2935	" "	8.5	" . . .	4	7.35	231.70	P.	H.	{ 350°, 10".
2936	" "	8.5	" . . .	4	7.45	231.87	S.	H.	
2937	" "	8.6	" . . .	4	5.08	141.78	S.	H.	130°, 10".
2938	" "	8.8	70 P. Ophiuchi .	4	27.87	142.27	P.	H.	190°, 3".
2939	" "	8.9	" . . .	4	20.12	232.42	P.	H.	60°, 4". [to continue.
2940	" "	8.9	" . . .	4	23.93	233.82	S.	H.	60°, 4". Seeing too bad
Total Number . .				14896					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
2941	June 19	9.3	67 Ophiuchi . . .	4	9.47	229.18	P.	H.	280°, 7".
2942	" "	9.3	" . . .	4	6.75	139.10	P.	H.	110°, 7".
2943	" "	9.4	" . . .	4	8.20	137.45	S.	H.	95°, 6".
2944	" "	9.4	" . . .	4	10.65	228.60	S.	H.	265°, 6".
2945	" "	9.7	α Bootis . . .	4	24.27	225.83	S.	H.	10°, 8".
2946	" "	9.7	" . . .	4	20.13	136.47	S.	H.	170°, 8".
2947	" "	9.8	" . . .	4	20.90	137.25	P.	H.	290°, 6".
2948	" "	9.9	" . . .	4	20.92	228.02	P.	H.	130°, 6".
2949	June 20	7.7	Sky . . .	39			U.	I.	For const. Var. aperts.
2950	" "	8.3	α Herculis . . .	4	27.52	135.68	U.	H.	130°, 10". [ing 4, 6, 4.
2951	" "	8.4	" . . .	4	27.78	226.32	U.	H.	320°, 8". June 20. See-
2952	" "	8.4	Distant Lamp . . .	5	3.642		S.	[I.]	{ For const. Pencils not coincident in first set.
2953	" "	8.6	" " . . .	5	3.326		P.	[I.]	
2954	" "	8.5	α Herculis . . .	4	31.20	225.05	S.	H.	340°, 8".
2955	" "	8.6	" . . .	4	30.65	137.05	S.	H.	110°, 8".
2956	" "	8.8	35 Comæ Ber. AB, C	4	7.15	137.55	U.	H.	0°, 6".
2957	" "	8.9	" " AB, C	4	6.58	226.92	U.	H.	185°, 5".
2958	" "	9.2	43 Herculis . . .	4	14.25	228.40	S.	H.	{ 270°, 3". Images indis- tinct, in line, A out of field.
2959	" "	9.3	" . . .	4	8.23	138.03	S.	H.	
2960	" "	9.3	Distant Lamp . . .	5	3.390		U.	I.	For constant.
2961	" "	9.4	43 Herculis . . .	4	11.37	136.88	U.	H.	300°, 10".
2962	" "	9.5	" . . .	4	10.22	227.42	U.	H.	270°, 7".
2963	" "	9.7	β Scorpil . . .	4	18.85	229.45	S.	H.	100°, 4".
2964	" "	9.8	" . . .	4	21.30	139.95	S.	H.	310°, 4".
2965	" "	9.8	" . . .	4	20.77	139.52	U.	H.	300°, 4".
2966	" "	9.9	" . . .	4	19.87	228.78	U.	H.	100°, 4".
2967	June 21	7.3	Sky . . .	39			P.	I.	{ For const. Var. aperts. Colors mark'd in 1st set.
2968	" "	7.7	" . . .	39			U.	I.	
2969	June 22	6.2	" . . .	39			S.	I.	For const. Var. aperts.
2970	June 23	10.1	ζ Coronæ . . .	4	36.12	138.37	P.	H.	280°, 3". [ing 4, 6, 5.
2971	" "	10.1	" . . .	4	33.53	228.68	P.	H.	30°, 3". June 23. See-
2972	" "	10.2	" . . .	4	35.68	226.82	S.	H.	{ 320°, 3". } At long inter- vals, thro' clds.
2973	" "	10.4	" . . .	4	34.85	137.85	S.	H.	
2974	" "	10.9	44 Bootis . . .	4	29.15	140.25	P.	H.	90°, 3". Pretty clear.
2975	" "	10.9	" . . .	4	32.15	139.95	S.	H.	80°, 3".
2976	" "	11.0	" . . .	4	33.02	228.78	P.	H.	240°, 3".
2977	" "	11.1	" . . .	4	33.25	228.55	S.	H.	225°, 3".
2978	" "	11.4	Jupiter III . . .	5	1.384		P.	I.	{ Ap. 12.7 cms. Pencils not coincident in first set.
2979	" "	11.6	" III . . .	5	1.204		P.	I.	
2980	" "	11.9	μ Sagittarii D . . .	5	5.256		P.	I.	{ Aperture 12.7 cms. Aperture 12.7 cms. Satellite near disap- pearance. Last set of 18 readings taken during diminution of light.
2981	" "	12.0	" E . . .	5	2.394		P.	I.	
2982	" "	12.2	Jupiter III . . .	5	1.200		P.	I.	
2983	" "	12.3	" III . . .	5	1.208		P.	I.	
2984	" "	12.4	" III . . .	5	1.142		P.	I.	
2985	" "	12.4	" III . . .	5	1.216		P.	I.	
2986	" "	12.4	" III . . .	5	1.180		P.	I.	{ For const. Var. aperts.
2987	" "	12.6	" III . . .	18			U.	I.	
2988	June 24	7.7	Sky . . .	39			U.	H.	280°, 6". [ing 6, 8, 7.
2989	" "	8.3	ν Scorpil A, BC . . .	4	20.70	140.20	U.	H.	80°, 5". June 24. See-
2990	" "	8.4	" A, BC . . .	4	21.30	231.00	P.	H.	110°, 3". [too distant.
2991	" "	8.6	σ² Ursæ Majoris . . .	4	15.40	231.40	P.	H.	220°, 3". Images a little
2992	" "	8.6	" " . . .	4	14.22	139.88	S.	H.	250°, 3". Doubtful, on
2993	" "	8.7	" " . . .	4	11.10	140.25	P.	H.	20°, 3". [acct. of clouds.
2994	" "	9.1	φ Virginis . . .	4	8.27	139.68	P.	H.	{ 170°, 3".
2995	" "	9.1	" . . .	4	10.82	228.77	P.	H.	
2996	" "	9.2	" . . .	4	8.75	229.25	S.	H.	40°, 3".
2997	" "	9.2	" . . .	4	9.10	140.20	S.	H.	
2998	" "	9.6	ε Virginis . . .	5	1.088		P.	I.	
2999	" "	9.7	" . . .	5	.940		S.	I.	[ing 8, 7, 2.
3000	June 25	8.3	ν Scorpil A, BC . . .	4	19.57	138.73	P.	H.	270°, 7". June 25. See-
Total Number . .				15339					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3001	June 25	8.3	ν Scorpii A, BC . .	4	19.35	228.45	P.	H.	} 90°, 5". 270°, 6". 10°, 6". 190°, 6". 190°, 5". 355°, 5". 315°, 8". 90°, 5". 90°, 7". Scarcely visible. 330°, 7".
3002	" "	8.4	" A, BC . .	4	19.50	228.80	U.	H.	
3003	" "	8.4	" A, BC . .	4	18.63	137.57	U.	H.	
3004	" "	8.6	θ Virginis A, C . .	4	3.45	138.25	U.	H.	
3005	" "	8.6	" A, C . .	4	3.40	228.25	U.	H.	
3006	" "	8.8	β Serpentis . . .	4	3.52	226.37	U.	H.	
3007	" "	8.9	" . . .	4	3.72	136.48	U.	H.	
3008	" "	9.1	η Lupi . . .	4	7.40	228.05	U.	H.	
3009	" "	9.2	" . . .	4	7.55	138.10	U.	H.	
3010	" "	9.3	" . . .	4	7.85	138.50	S.	H.	
3011	" "	9.5	" . . .	4	11.85	227.95	S.	H.	
3012	June 26	7.8	Sky . . .	39			P.	I.	For const. Var. ap. Dark- 185°, 5". [ness makes set- tings difficult. 40°, 5". June 26. See- 70°, 3". [ing 8, 5, 7. 150°, 3". 110°, 5". 250°, 5". 260°, 3". 110°, 3". 300°, 4". 45°, 3". 50°, 3". 290°, 3". } 100°, 60". In line.
3013	" "	8.6	70 P. Ophiuchi . .	4	21.65	136.85	U.	H.	
3014	" "	8.6	" . . .	4	25.68	227.48	U.	H.	
3015	" "	8.7	" . . .	4	21.20	233.10	P.	H.	
3016	" "	8.8	" . . .	4	27.98	142.48	P.	H.	
3017	" "	8.9	67 Ophiuchi . . .	4	6.78	227.98	P.	H.	
3018	" "	8.9	" . . .	4	8.42	137.82	P.	H.	
3019	" "	8.9	" . . .	4	7.62	138.58	U.	H.	
3020	" "	9.0	" . . .	4	8.67	227.82	U.	H.	
3021	" "	9.1	59 Serpentis . . .	4	19.85	140.60	U.	H.	
3022	" "	9.2	" . . .	4	21.48	229.08	U.	H.	
3023	" "	9.2	" . . .	4	21.52	229.62	P.	H.	} A out of field. 110°, 3". 300°, 4". 45°, 3". 50°, 3". 290°, 3". } 100°, 60". In line.
3024	" "	9.3	" . . .	4	20.85	141.20	P.	H.	
3025	" "	9.4	η Serpentis . . .	4	1.42	136.22	P.	H.	
3026	" "	9.5	" . . .	4	1.92	226.67	P.	H.	
3027	" "	9.6	" . . .	5	2.822		P.	I.	
3028	" "	10.6	Menippe, γ Libræ .	5	2.236		P.	I.	
3029	" "	10.8	" " . . .	5	1.700		U.	I.	
3030	June 28	9.0	μ Herculis . . .	4	2.72	228.27	U.	H.	
3031	" "	9.1	" . . .	4	2.72	138.10	U.	H.	
3032	" "	9.2	" . . .	4	3.00	137.70	S.	H.	
3033	" "	9.2	" . . .	4	3.23	227.78	S.	H.	} 210°, 5". } 5°, 5". 300°, 5". 135°, 4". 315°, 4". 330°, 5". 120°, 5". 180°, 3". June 29. See- 45°, 3". [ing 8, 7, 6. 50°, 3". 200°, 3". 120°, 10". 270°, 10". 275°, 10". 95°, 10". 280°, 3". 55°, 3". 60°, 3". 310°, 3". } For const. Light of lamp seems variable. 110°, 60". } In line, A out of field. 95°, 60". 95°, 60".
3034	" "	9.5	ν Serpentis . . .	4	7.22	228.12	U.	H.	
3035	" "	9.5	" . . .	4	8.62	138.12	U.	H.	
3036	" "	9.5	" . . .	4	6.42	137.62	P.	H.	
3037	" "	9.6	" . . .	4	8.12	227.77	P.	H.	
3038	June 29	8.4	70 P. Ophiuchi . .	4	28.85	139.10	S.	H.	
3039	" "	8.5	" . . .	4	24.30	229.85	S.	H.	
3040	" "	8.6	" . . .	4	23.15	232.30	P.	H.	
3041	" "	8.7	" . . .	4	27.22	141.47	P.	H.	
3042	" "	8.7	67 Ophiuchi . . .	4	7.73	227.52	P.	H.	
3043	" "	8.8	" . . .	4	8.60	136.80	P.	H.	
3044	" "	8.8	" . . .	4	7.72	136.97	S.	H.	} A out of field. In 3d set, re- duced image elongated transversely to line join- ing it with B. In 4th set, B elongated as above. } For const. Light of lamp seems variable. 110°, 60". } In line, A out of field. 95°, 60". 95°, 60".
3045	" "	8.9	" . . .	4	6.32	227.82	S.	H.	
3046	" "	9.1	59 Serpentis . . .	4	20.25	139.50	S.	H.	
3047	" "	9.2	" . . .	4	21.55	229.05	S.	H.	
3048	" "	9.3	" . . .	4	21.30	230.70	P.	H.	
3049	" "	9.4	" . . .	4	23.00	139.55	P.	H.	
3050	" "	9.0	Distant Lamp . . .	5	3.564		P.	I.	
3051	" "	9.3	" " . . .	5	2.964		S.	I.	
3052	" "	9.5	η Serpentis . . .	4	1.40	136.65	P.	H.	
3053	" "	9.5	" . . .	4	1.65	226.90	P.	H.	
3054	" "	9.6	" . . .	4	2.27	226.82	S.	H.	
3055	" "	9.7	" . . .	4	1.80	137.05	S.	H.	} Disappearance of Ju- piter I.
3056	" "	9.9	" . . .	5	3.672		P.	I.	
3057	" "	10.0	" . . .	5	5.682		S.	I.	
3058	" "	13.6	Jupiter I, II . . .	12	41.88		P.	H.	
3059	" "	13.9	" I, II . . .	10	40.63		P.	H.	
3060	" "	14.0	" I, II . . .	9			P.	H.	
Total Number . .				15640					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3061	June 30	7.8	β Scorpii . . .	4	19.65	231.55	P.	H.	120°, 3". June 30. See-
3062	" "	7.9	" . . .	4	19.70	141.60	P.	H.	310°, 3". [ing 6, 7, 7.
3063	" "	8.3	μ Draconis . . .	4	46.10	139.65	P.	H.	20°, 3".
3064	" "	8.4	" . . .	4	44.15	138.25	P.	H.	
3065	" "	8.4	" . . .	4	41.10	138.15	S.	H.	30°, 3".
3066	" "	8.5	" . . .	4	43.02	139.92	S.	H.	180°, 3".
3067	" "	8.8	σ^2 Ursæ Majoris .	4	13.38	233.02	P.	H.	120°, 3". Seen with dif-
3068	" "	8.8	" " . . .	4	16.67	141.47	P.	H.	240°. [ficulty.
3069	" "	9.1	ϵ Virginis . . .	5	1.232		P.	I.	
3070	" "	9.1	" . . .	5	.996		S.	I.	
3071	" "	9.6	α Serpentis . . .	5	2.380		S.	I.	
3072	" "	9.7	" . . .	6	2.407		P.	I.	
3073	" "	9.9	" . . .	4	.67	228.82	S.	H.	85°, 8". } A out of field.
3074	" "	10.0	" . . .	4	.35	138.05	S.	H.	250°, 8". } Reflected image
3075	" "	10.1	" . . .	4	.47	138.52	P.	H.	250°, 8". } much brighter
3076	" "	10.2	" . . .	4	.67	228.87	P.	H.	100°, 8". } [than B.
3077	" "	10.8	σ Scorpii . . .	4	5.02	229.42	P.	H.	170°, 8".
3078	" "	10.8	" . . .	4	4.42	141.72	P.	H.	340°, 8".
3079	" "	10.9	" . . .	4	5.10	141.70	S.	H.	335°, 8".
3080	" "	10.9	" . . .	4	5.45	231.75	S.	H.	185°, 8".
3081	" "	11.1	ν Serpentis . . .	4	8.25	137.20	S.	H.	310°, 4".
3082	" "	11.1	" . . .	4	7.10	227.45	S.	H.	100°, 4".
3083	" "	11.4	μ Sagittarii A, C .	4	5.62	137.37	S.	H.	10°, 4". A out of field.
3084	" "	11.5	" A, C .	4	5.10	227.60	S.	H.	210°, 5".
3085	" "	11.5	" A, C .	4	5.45	227.20	P.	H.	210°, 6".
3086	" "	11.6	" A, C .	4	4.80	137.25	P.	H.	20°, 6".
3087	" "	11.7	" A, B .	4	3.85	137.50	P.	H.	200°, 6". A out of field.
3088	" "	11.7	" A, B .	4	4.10	227.15	P.	H.	40°, 6".
3089	" "	11.8	" A, B .	4	4.70	227.55	S.	H.	50°, 6".
3090	" "	11.8	" A, B .	4	3.67	137.42	S.	H.	210°, 6".
3091	" "	12.3	Jupiter II, III . .	9	36.65	320.31	S.	H.	Disappearance of Ju- piter II.
3092	" "	12.4	" II, III . .	10	34.91	321.23	S.	H.	
3093	" "	12.6	" II, III . .	10	35.84	320.54	S.	H.	
3094	" "	12.7	" II, III . .	11	35.43	320.51	S.	H.	
3095	" "	12.8	" II, III . .	18			S.	H.	Limit of visibility.
3096	" "	12.9	" III . . .	4	9.32	321.72	S.	H.	
3097	" "	22.9	Sky . . .	39			S.	I.	For const. Var. ap. Field
3098	July 1	8.1	95 Herculis . . .	4	45.87	140.97	U.	H.	45°, 5". [mottled and
3099	" "	8.2	" . . .	4	42.85	230.30	U.	H.	250°, 5". July 1. See-
3100	" "	8.3	" . . .	4	46.77	139.43	P.	H.	250°, 5". [ing 7, 5, 6.
3101	" "	8.3	" . . .	4	44.20	141.85	P.	H.	20°, 5".
3102	" "	8.6	67 Ophiuchi . . .	4	10.72	229.62	U.	H.	270°, 4".
3103	" "	8.6	" . . .	4	7.20	139.65	U.	H.	90°, 4".
3104	" "	8.7	φ Virginis . . .	4	9.23	140.62	P.	H.	60°, 3".
3105	" "	8.8	" . . .	4	9.28	231.58	P.	H.	180°, 3".
3106	" "	8.9	" . . .	4	7.98	230.62	U.	H.	193°, 3".
3107	" "	8.9	" . . .	4	8.03	140.52	U.	H.	30°, 3".
3108	" "	9.1	σ Scorpii . . .	4	4.57	227.63	U.	H.	180°, 4". Images blurred.
3109	" "	9.2	" . . .	4	4.05	137.45	U.	H.	0°, 4".
3110	" "	9.3	α Serpentis . . .	4	.50	137.35	U.	H.	90°, 8". A out of field.
3111	" "	9.4	" . . .	4	.65	227.25	U.	H.	270°, 6".
3112	" "	9.5	" . . .	4	.55	227.45	S.	H.	265°, 6".
3113	" "	9.6	" . . .	4	.47	137.23	S.	H.	80°, 6".
3114	" "	9.5	γ Aquilæ . . .	5	2.472		P.	I.	For constant. Part of direct pencil perhaps lost in first set.
3115	" "	9.7	β Aquilæ . . .	5	3.386		U.	I.	
3116	" "	9.8	" . . .	5	3.006		S.	I.	For const. Clouds in first set. Perhaps not α Aqi- læ part of second set.
3117	" "	10.2	α Aquilæ . . .	5	3.354		P.	I.	
3118	July 2	8.7	α Aquilæ . . .	6	3.210		S.	I.	190°, 12".
3119	" "	9.2	" . . .	5	3.308		U.	I.	
3120	" "	8.9	17 Draconis A, B .	4	47.00	139.60	U.	H.	
Total Number . .				15965					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3121	July 2	9.0	17 Draconis A, B .	4	52.75	136.55	U.	H.	190°, 12". July 2. See-
3122	" "	9.1	" A, C .	4	27.95	136.75	U.	H.	45°, 5". [ing 6, 5, 6.
3123	" "	9.1	" A, C .	4	28.20	229.55	U.	H.	200°, 5".
3124	" "	9.2	" A, C .	4	32.15	230.40	S.	H.	200°, 3".
3125	" "	9.3	" A, C .	4	30.45	139.95	S.	H.	350°, 3".
3126	" "	9.5	" A, B .	4	43.95	138.35	S.	H.	190°, 12". Focus bad.
3127	" "	9.6	" A, B .	4	49.82	140.72	S.	H.	200°, 12".
3128	July 3	8.1	μ Draconis . . .	4	45.52	140.47	U.	H.	135°, 4". July 3. See-
3129	" "	8.2	" . . .	4	43.35	229.30	U.	H.	30°, 3". [ing 7, 6, 7.
3130	" "	8.5	α Aquilæ . . .	5	3.058		P.	I.	} For constant.
3131	" "	8.6	" . . .	5	3.044		U.	I.	
3132	" "	8.5	39 Draconis A, C .	4	13.75	139.25	S.	H.	180°, 4".
3133	" "	8.5	" A, C .	4	19.55	227.85	S.	H.	45°, 4".
3134	" "	8.6	" A, B .	4	15.22	227.07	S.	H.	130°, 14". A out of field.
3135	" "	8.7	" A, B .	4	17.52	138.82	S.	H.	} 140°, 14".
3136	" "	8.8	" A, B .	4	12.38	138.17	U.	H.	
3137	" "	8.8	" A, B .	4	13.35	228.15	U.	H.	} 80°, 2".
3138	" "	8.9	" A, C .	4	14.27	229.12	U.	H.	
3139	" "	9.0	" A, C .	4	16.75	140.50	U.	H.	190°, 2". Seeing excel-
3140	" "	8.8	α Aquilæ . . .	5	2.434		S.	I.	For constant. [lent.
3141	" "	9.2	μ Sagittarii A, B .	4	4.67	140.02	P.	H.	270°, 7".
3142	" "	9.3	" A, B .	4	3.75	230.20	P.	H.	60°, 7".
3143	" "	9.3	" A, C .	4	4.00	139.80	P.	H.	70°, 5". A out of field.
3144	" "	9.4	" A, C .	4	4.95	229.80	P.	H.	220°.
3145	" "	9.4	" A, C .	4	4.62	229.82	U.	H.	200°, 6". A out of field.
3146	" "	9.5	" A, C .	4	4.72	140.42	U.	H.	45°, 5".
3147	" "	9.5	" A, B .	4	5.27	230.22	U.	H.	45°, 5". A in field.
3148	" "	9.6	" A, B .	4	3.87	140.17	U.	H.	270°, 5".
3149	" "	9.9	36 Ophiuchi . . .	4	43.42	231.92	U.	H.	270°, 3".
3150	" "	10.0	" . . .	4	44.02	233.42	U.	H.	160°, 3".
3151	" "	10.1	" . . .	4	46.22	142.17	S.	H.	140°, 3".
3152	" "	10.3	" . . .	4	46.00	145.35	S.	H.	270°, 3".
3153	July 4	8.7	ι Bootis . . .	4	13.47	139.12	U.	H.	355°, 4". July 4. See-
3154	" "	8.8	" . . .	4	10.80	230.15	U.	H.	190°, 4". [ing 7, 4, 6.
3155	" "	8.8	" . . .	4	11.70	230.30	S.	H.	185°, 4".
3156	" "	8.9	" . . .	4	11.85	141.85	S.	H.	15°, 4".
3157	" "	9.0	α Bootis . . .	4	20.17	231.67	U.	H.	210°, 3".
3158	" "	9.1	" . . .	4	21.22	141.42	U.	H.	45°, 3".
3159	" "	8.8	α Ursæ Minoris .	5	3.160		P.	I.	} For constant.
3160	" "	8.8	" " . . .	5	3.176		U.	I.	
3161	" "	9.3	" " . . .	5	3.032		S.	I.	} 220°, 3".
3162	" "	9.2	44 Bootis . . .	4	37.75	141.20	U.	H.	
3163	" "	9.3	" . . .	4	37.87	233.27	U.	H.	90°, 4".
3164	" "	9.4	" . . .	4	35.88	142.12	P.	H.	90°, 3".
3165	" "	9.4	" . . .	4	37.57	141.62	P.	H.	200°, 3".
3166	July 5	8.2	θ Serpentis . . .	4	38.45	139.45	P.	H.	220°, 5". } Obj.-glass prob-
3167	" "	8.2	" . . .	4	37.02	141.33	P.	H.	90°, 5". } ably partly cov-
3168	" "	8.2	" . . .	4	39.70	140.20	U.	H.	100°, 4". } ered by dome.
3169	" "	8.3	" . . .	4	40.55	140.30	U.	H.	210°, 4". July 5. See-
3170	" "	8.7	ε Sagittæ . . .	4	11.52	138.43	U.	H.	135°, 15". A out of field.
3171	" "	8.8	" . . .	4	15.40	228.00	U.	H.	135°, 15".
3172	" "	8.8	" . . .	4	12.17	229.37	S.	H.	} 140°, 15".
3173	" "	8.9	" . . .	4	11.02	138.37	S.	H.	
3174	" "	8.8	γ Aquilæ . . .	5	3.374		P.	I.	} For constant.
3175	" "	8.9	" . . .	5	3.352		U.	I.	
3176	" "	9.1	ζ Sagittæ . . .	4	9.85	229.30	S.	H.	85°, 5".
3177	" "	9.2	" . . .	4	10.45	139.65	S.	H.	290°, 5".
3178	" "	9.3	" . . .	4	10.50	139.25	U.	H.	300°, 5".
3179	" "	9.3	" . . .	4	10.50	229.60	U.	H.	80°, 4". [yellowish.
3180	" "	9.5	P. XX 63, σ^2 Cygni	4	11.60	138.60	S.	H.	250°, 25". A reddish, B
Total Number . .				16213					

No. for Reference.	Date, 1878.		Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3181	July	5	9.6	P. XX 63, α^2 Cygni	4	13.53	228.82	S.	H.	250°, 25".
3182	"	"	9.7	"	4	14.50	228.55	U.	H.	270°, 30". B bluish.
3183	"	"	9.7	"	4	13.48	137.58	U.	H.	
3184	"	"	9.9	61 Cygni . . .	4	38.40	139.10	U.	H.	100°, 5".
3185	"	"	10.0	" . . .	4	34.15	231.55	U.	H.	270°, 4".
3186	"	"	10.0	" . . .	4	34.95	229.35	P.	H.	80°, 3".
3187	"	"	10.1	" . . .	4	34.25	139.40	P.	H.	300°, 3".
3188	July	6	7.7	Sky . . .	39			S.	I.	For const. Var. aperts.
3189	"	"	8.2	ρ Herculis . . .	4	33.27	142.38	P.	H.	120°, 3". July 6. See-
3190	"	"	8.3	" . . .	4	32.45	233.10	P.	H.	0°, 3". [ing 5, 4, 4.
3191	"	"	8.5	β Lyrae . . .	4	8.55	142.55	P.	H.	120°, 3". A out of field.
3192	"	"	8.5	" . . .	4	8.33	142.52	S.	H.	110°, 3". Refocussed.
3193	"	"	8.6	" . . .	4	9.40	231.75	P.	H.	300°, 3". Refocussed.
3194	"	"	8.6	" . . .	4	9.30	232.30	S.	H.	300°, 3".
3195	"	"	8.8	5 Serpentis . . .	4	7.30	232.75	P.	H.	330°, 6".
3196	"	"	8.9	" . . .	4	6.13	143.07	P.	H.	{ 90°, 5".
3197	"	"	9.0	" . . .	4	7.52	142.78	S.	H.	
3198	"	"	9.1	" . . .	4	8.43	233.22	S.	H.	315°, 5". Not seen after
3199	"	"	9.3	43 Herculis . . .	4	8.87	140.78	P.	H.	{ 270°, 12". [last setting.
3200	"	"	9.4	" . . .	4	9.60	230.40	P.	H.	
3201	"	"	9.5	44 Bootis . . .	4	34.70	142.05	S.	H.	80°, 3". Refocussed.
3202	"	"	9.7	" . . .	4	38.15	230.95	S.	H.	250°, 3". Refocussed.
3203	"	"	9.8	ι Bootis . . .	4	11.97	140.32	P.	H.	30°, 6".
3204	"	"	9.9	" . . .	4	12.25	230.20	P.	H.	310°, 6".
3205	July	7	8.4	θ Serpentis . . .	4	38.15	141.90	P.	H.	250°, 5".
3206	"	"	8.5	" . . .	4	37.75	141.95	P.	H.	70°, 3".
3207	"	"	8.7	95 Herculis . . .	4	44.60	144.10	P.	H.	70°, 4".
3208	"	"	8.7	" . . .	4	44.32	144.02	P.	H.	250°, 3".
3209	"	"	8.9	ϵ Sagittae . . .	4	12.45	138.25	P.	H.	{ 135°, 15".
3210	"	"	9.0	" . . .	4	14.02	228.07	P.	H.	
3211	"	"	9.0	ζ Sagittae . . .	4	11.23	232.62	P.	H.	290°, 5".
3212	"	"	9.1	" . . .	4	9.52	142.17	P.	H.	120°, 4".
3213	"	"	9.3	17 χ Cygni . . .	4	12.35	232.10	P.	H.	70°, 5".
3214	"	"	9.3	" . . .	4	10.97	142.32	P.	H.	250°, 5".
3215	"	"	9.5	61 Cygni . . .	4	34.12	142.67	P.	H.	270°, 5".
3216	"	"	9.5	" . . .	4	34.45	235.10	P.	H.	100°, 5".
3217	"	"	9.6	P. XX 63, α^2 Cygni	4	13.20	229.00	P.	H.	270°, 35". { A yellow, B blue, colors marked. A out of field.
3218	"	"	9.7	"	4	12.05	140.25	P.	H.	
3219	"	"	15.0	Jupiter II, III . .	10	38.32	141.52	P.	H.	
3220	"	"	15.0	" II, III . .	10	37.78	141.22	P.	H.	
3221	"	"	15.1	" II . .	8	49.00	140.32	P.	H.	II projected on shadow [of I.
3222	"	"	15.3	" II, III . .	10	37.50	142.06	P.	H.	
3223	"	"	15.3	" II, III . .	8	37.77	142.00	P.	H.	
3224	"	"	15.3	" II, III . .	14			P.	H.	Disap. of Jupiter II.
3225	"	"	15.4	" III . .	10	11.85	141.93	P.	H.	Limit of visibility.
3226	July	8	7.8	Sky . . .	39			S.	I.	For const. Var. aperts.
3227	"	"	8.6	39 Ophiuchi . .	4	25.85	137.25	U.	H.	{ 280°, 4". July 8. Seeing
3228	"	"	8.7	" . . .	4	28.05	228.40	U.	H.	{ 5, 5, 5. Seeing good.
3229	"	"	8.7	" . . .	4	25.90	229.55	S.	H.	90°, 4". Clouds, seeing bad.
3230	"	"	8.9	" . . .	4	28.40	138.50	S.	H.	300°, 3". Seeing improved.
3231	"	"	9.2	21 Sagittarii . .	4	19.08	230.33	U.	H.	25°, 2". } Clouds. 240°, 2". }
3232	"	"	9.3	" . . .	4	17.00	141.90	U.	H.	
3233	"	"	10.0	42 Herculis . . .	4	5.20	230.55	U.	H.	270°, 5". [not uniform.
3234	July	9	7.7	Sky . . .	39			S.	I.	For const. Var. ap. Field
3235	"	"	9.8	β Lyrae . . .	4	12.07	137.28	S.	H.	300°, 5". July 9. See-
3236	"	"	9.9	" . . .	4	12.35	227.95	S.	H.	140°, 5". [ing 5, 7, 7.
3237	July	10	8.6	φ Virginis . . .	4	8.80	232.45	S.	H.	170°, 4". } Observ. barely possible. Refo- cussed for 2d set.
3238	"	"	8.9	" . . .	4	10.17	140.88	S.	H.	
3239	"	"	9.3	η Lupi . . .	4	6.88	230.07	S.	H.	90°, 8". July 10. See-
3240	"	"	9.3	" . . .	4	8.40	140.20	S.	H.	300°, 8". [ing 6, 8, 6.
Total Number . .					16600					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3241	July 10	9.8	42 Herculis . . .	4	6.35	139.90	S.	H.	0°, 6".
3242	" "	9.9	" . . .	4	5.03	230.73	S.	H.	240°, 6".
3243	July 13	8.2	ψ Draconis . . .	4	30.82	226.73	S.	H.	80°, 4". July 13. See-
3244	" "	8.3	" . . .	4	28.28	136.77	S.	H.	230°, 4". [ing 5, 4, 4.
3245	" "	8.4	" . . .	4	32.77	137.43	P.	H.	250°, 3".
3246	" "	8.4	" . . .	4	27.20	228.10	P.	H.	100°, 4".
3247	" "	8.6	η Lupi . . .	4	8.05	230.55	P.	H.	90°, 5".
3248	" "	8.6	" . . .	4	8.85	139.40	P.	H.	300°, 5".
3249	" "	8.7	36 Ophiuchi . . .	4	43.52	141.33	P.	H.	140°, 3".
3250	" "	8.8	" . . .	4	44.82	140.32	P.	H.	290°, 3".
3251	" "	8.8	" . . .	4	42.70	139.20	S.	H.	280°, 3".
3252	" "	8.9	" . . .	4	45.97	139.92	S.	H.	150°, 3".
3253	" "	9.1	39 Ophiuchi . . .	4	27.00	139.30	P.	H.	300°, 6".
3254	" "	9.2	" . . .	4	27.38	228.12	P.	H.	70°, 6".
3255	" "	9.3	μ Sagittarii A, C .	4	4.63	136.12	S.	H.	35°, 6".
3256	" "	9.4	" A, C .	4	4.80	226.40	S.	H.	240°, 6".
3257	" "	9.5	" A, B .	4	3.75	226.30	S.	H.	220°, 6".
3258	" "	9.5	" A, B .	4	3.97	135.58	S.	H.	85°, 6".
3259	" "	9.7	β Lyrae . . .	4	9.50	230.20	P.	H.	300°, 3".
3260	" "	9.8	" . . .	4	9.70	140.60	P.	H.	120°, 3".
3261	" "	9.8	" . . .	4	7.88	140.67	S.	H.	115°, 3".
3262	" "	9.9	" . . .	4	10.35	230.50	S.	H.	280°, 3".
3263	July 15	8.5	θ Serpentis . . .	4	27.60	229.75	S.	H.	325°, 6". July 15. See-
3264	" "	8.6	" . . .	4	25.02	140.08	S.	H.	170°, 6". [ing 4, 5, 5.
3265	" "	8.7	" . . .	4	24.70	141.25	P.	H.	160°, 6".
3266	" "	8.8	" . . .	4	31.18	231.72	P.	H.	330°, 4". Pass'g clouds.
3267	" "	9.8	P. XX 63, σ^2 Cygni	4	15.20	228.85	P.	H.	270°, 40". In line, A out
3268	" "	9.8	" . . .	4	13.45	139.10	P.	H.	270°, 40". [of field, B
3269	" "	9.9	" . . .	4	13.45	139.55	S.	H.	blue.
3270	" "	9.9	" . . .	4	11.85	228.75	S.	H.	{ 270°, 30".
3271	" "	10.1	61 Cygni . . .	4	32.57	226.17	S.	H.	110°, 4".
3272	" "	10.1	" . . .	4	35.58	137.13	S.	H.	265°, 4".
3273	" "	10.2	" . . .	4	35.50	136.70	P.	H.	275°, 5".
3274	" "	10.3	" . . .	4	32.97	230.27	P.	H.	110°, 5".
3275	" "	10.4	17 χ Cygni . . .	4	10.85	228.25	P.	H.	70°, 5".
3276	" "	10.4	" . . .	4	11.07	137.22	P.	H.	{ 240°, 4".
3277	" "	10.5	" . . .	4	11.10	137.80	S.	H.	
3278	" "	10.5	" . . .	4	12.55	226.60	S.	H.	60°, 4".
3279	" "	10.6	ζ Sagittae . . .	4	11.10	231.95	S.	H.	270°, 3".
3280	" "	10.7	" . . .	4	10.02	141.73	S.	H.	85°, 3".
3281	" "	10.8	" . . .	4	10.60	142.85	P.	H.	80°, 3".
3282	" "	10.8	" . . .	4	11.10	233.55	P.	H.	290°, 3".
3283	" "	10.9	ε Sagittae . . .	4	14.70	228.25	P.	H.	120°, 20". In line, A out
3284	" "	10.9	" . . .	4	12.82	138.88	P.	H.	120°, 20". [of field.
3285	" "	11.0	" . . .	4	15.35	137.25	S.	H.	{ 100°, 15".
3286	" "	11.0	" . . .	4	16.22	226.87	S.	H.	
3287	" "	11.2	36 Ophiuchi . . .	4	43.80	142.35	P.	H.	300°, 3".
3288	" "	11.3	" . . .	4	43.95	143.00	P.	H.	120°, 4".
3289	" "	12.2	Jupiter I . . .	4	1.218		S.	I.	
3290	" "	12.3	" I . . .	5	1.226		S.	I.	
3291	" "	12.3	" I . . .	3			S.	I.	Disap. of Jupiter I.
3292	" "	12.4	" . . .	1	.57		S.	I.	Limit of visibility.
3293	July 16	8.5	95 Herculis . . .	4	43.40	141.90	P.	H.	30°, 3". July 16. See-
3294	" "	8.6	" . . .	4	47.72	141.82	P.	H.	220°, 3". [ing 3, 6, 6.
3295	" "	8.6	" . . .	4	40.23	140.03	S.	H.	160°, 4".
3296	" "	8.7	" . . .	4	43.20	140.15	S.	H.	20°, 4".
3297	" "	8.8	β Lyrae . . .	4	10.08	139.62	P.	H.	150°, 5". A out of field.
3298	" "	8.8	" . . .	4	14.05	228.70	P.	H.	{ 270°, 5".
3299	" "	8.9	" . . .	4	12.45	229.29	S.	H.	
3300	" "	8.9	" . . .	4	9.90	139.60	S.	H.	140°, 5".
Total Number . . .				16837					

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No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3301	July 16	9.1	17 χ Cygni . . .	4	10.80	140.70	S.	H.	50°, 4".
3302	" "	10.1	" " " " . . .	4	10.65	226.40	S.	H.	200°, 4".
3303	July 17	9.4	17 χ Cygni . . .	4	12.47	228.47	P.	H.	250°, 5". July 17. See-
3304	" "	9.5	" " " " . . .	4	10.20	138.60	P.	H.	60°, 5". [ing 3, 7, 7.
3305	" "	9.8	59 Serpentis . . .	4	20.13	232.62	S.	H.	30°, 4". Clouds trouble-
3306	" "	9.9	" " " " . . .	4	18.47	142.47	S.	H.	265°, 4". [some.
3307	July 19	7.9	ψ Draconis . . .	4	28.35	138.50	P.	H.	270°, 5". July 19. See-
3308	" "	7.9	" " " " . . .	5	29.75	230.05	P.	H.	100°, 5". [ing 7, 8, 6.
3309	" "	8.2	17 Draconis Δ , C .	4	33.40	143.05	P.	H.	290°, 3". Near zenith.
3310	" "	8.3	" " Δ , C .	4	28.93	233.57	P.	H.	40°, 3".
3311	" "	8.4	" " Δ , B .	4	46.37	135.92	P.	H.	{ 40°, 20".
3312	" "	8.4	" " Δ , B .	4	46.25	137.30	P.	H.	
3313	" "	8.6	η Lupi . . .	4	7.40	138.75	P.	H.	90°, 5".
3314	" "	8.7	" " " " . . .	4	9.83	228.07	P.	H.	310°, 5".
3315	" "	8.9	α Virginis . . .	5	.926		P.	I.	
3316	" "	8.9	" " " " . . .	5	.678		S.	I.	
3317	" "	9.1	α Serpentis . . .	5	2.730		S.	I.	
3318	" "	9.2	" " " " . . .	8	.30	138.95	P.	H.	260°, 10".
3319	" "	9.3	" " " " . . .	4	.72	228.93	P.	H.	60°, 10".
3320	" "	9.5	5 Serpentis . . .	4	7.60	230.35	P.	H.	300°, 5".
3321	" "	9.6	" " " " . . .	4	6.80	140.60	P.	H.	80°, 5". B too bright
3322	" "	9.9	η Serpentis . . .	5	5.256		S.	I.	[for Phot. I.
3323	" "	10.0	" " " " . . .	5	4.462		P.	I.	
3324	" "	10.1	" " " " . . .	4	1.73	138.22	P.	H.	{ 80°, 70".
3325	" "	10.1	" " " " . . .	4	2.00	228.15	P.	H.	
3326	" "	10.2	" " " " . . .	4	2.42	228.03	S.	H.	{ 80°, 60".
3327	" "	10.2	" " " " . . .	4	2.13	138.53	S.	H.	
3328	July 20	8.4	39 Draconis Δ , B .	4	14.15	227.10	P.	H.	180°, 15". AC out of field.
3329	" "	8.5	" " Δ , B .	4	13.72	137.78	P.	H.	180°, 15". Pass'g clouds.
3330	July 21	8.1	39 Draconis Δ , C .	4	15.43	230.78	P.	H.	{ 80°, 3". July 20. Seeing
3331	" "	8.2	" " Δ , C .	4	18.17	140.47	P.	H.	{ 2, 5, 5.
3332	" "	8.5	α Virginis . . .	5	1.468		P.	I.	{ 200°, 3". July 21. Seeing
3333	" "	9.0	α Bootis . . .	5	.606		P.	I.	{ 8, 5, 2.
3334	" "	9.1	" " " " . . .	5	.274		P.	I.	Prism much darker
3335	" "	9.2	ρ Bootis . . .	5	2.924		P.	I.	than sky.
3336	" "	9.7	μ Bootis . . .	4	17.70	137.70	P.	H.	Limit of visibility.
3337	" "	9.8	" " " " . . .	4	16.88	228.87	P.	H.	{ 120°, 30". In line, A
3338	July 22	9.1	β Lyrae . . .	4	11.90	137.85	P.	H.	
3339	" "	9.4	" " " " . . .	4	12.85	228.65	P.	H.	{ out of field.
3340	" "	9.5	110 Herculis . . .	4	1.15	228.15	P.	H.	{ 140°, 5". July 22. Seeing
3341	" "	9.6	" " " " . . .	4	.65	137.80	P.	H.	{ 8, 5, 5.
3342	" "	9.8	" " " " . . .	5	2.826		P.	I.	300°, 5". Delayed by
3343	July 23	8.5	39 Draconis Δ , C .	4	19.72	230.87	S.	H.	70°, 7". [clouds.
3344	" "	8.6	" " Δ , C .	4	19.88	140.13	S.	H.	280°, 10".
3345	" "	8.7	" " Δ , C .	4	19.32	140.97	P.	H.	C seen .7 dist. A to B.
3346	" "	8.8	" " Δ , C .	4	17.03	231.23	P.	H.	50°, 3". July 23. See-
3347	" "	8.8	" " Δ , B .	4	14.92	227.22	S.	H.	185°, 3". [ing 7, 6, 6.
3348	" "	8.9	" " Δ , B .	4	16.48	137.03	S.	H.	240°, 3".
3349	" "	9.0	" " Δ , B .	4	13.65	138.10	P.	H.	120°, 2".
3350	" "	9.1	" " Δ , B .	4	15.37	228.12	P.	H.	160°, 20". In line, A out
3351	" "	9.3	110 Herculis . . .	4	1.25	227.75	P.	H.	160°, 20". [of field.
3352	" "	9.4	" " " " . . .	4	.83	137.88	P.	H.	{ 200°, 20".
3353	" "	9.5	" " " " . . .	4	1.02	137.37	S.	H.	
3354	" "	10.1	" " " " . . .	5	.88	227.88	S.	H.	250°, 5". A out of field.
3355	July 24	8.5	μ Bootis . . .	4	19.75	227.75	S.	H.	30°, 10".
3356	" "	8.5	" " " " . . .	4	18.92	138.47	S.	H.	30, 10". Delayed by cl'ds
3357	" "	8.6	" " " " . . .	4	17.95	138.50	P.	H.	[and driving-
3358	" "	8.6	" " " " . . .	4	18.60	227.95	P.	H.	180°, 10". [clock.
3359	" "	8.7	α Bootis . . .	5	.592		P.	I.	100°, 30". In line, A
3360	" "	8.8	" " " " . . .	5	.524		S.	I.	120°, 30". [out of field.
Total Number . .				17095					150°, 35". July 24. See-
									[ing 8, 8, 8.

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3361	July 24	9.1	ρ Bootis	5	2.622		S.	I.	
3362	" "	9.2	"	5	3.186		P.	I.	
3363	" "	9.5	42 Herculis	4	4.38	233.18	S.	H.	90°, 6".
3364	" "	9.6	"	4	5.20	142.65	S.	H.	290°, 6".
3365	" "	9.7	"	4	5.20	142.70	P.	H.	290°, 10".
3366	" "	9.7	"	4	4.17	232.88	P.	H.	90°, 5".
3367	" "	10.0	ν^2 Coronæ	4	6.42	228.47	P.	H.	330°, 40". In line, A out
3368	" "	10.0	"	4	5.35	138.95	P.	H.	330°, 40". [of field.
3369	" "	10.1	"	4	6.87	138.38	S.	H.	{ 330°, 55".
3370	" "	10.2	"	4	7.15	228.35	S.	H.	
3371	July 31	8.1	μ Bootis	4	18.45	136.65	P.	H.	{ 130°, 35". In line, A out of field. Dome inter-feres towards end.
3372	" "	8.2	"	4	19.60	227.55	P.	H.	
3373	" "	8.2	"	4	15.60	225.85	S.	H.	90°, 30". Clouds fre-
3374	" "	8.4	"	4	15.47	135.73	S.	H.	110°, 30". [quent.
3375	Aug. 2	8.3	α Bootis	5	.672		P.	I.	Aug. 2. Seeing 6, 6, 6.
3376	" "	8.3	"	5	.688		S.	I.	
3377	" "	8.5	ρ Bootis	5	3.702		P.	I.	[after 1st setting.
3378	" "	8.5	"	5	2.380		S.	I.	Images brought closer
3379	" "	9.0	ν^2 Coronæ	4	4.43	137.18	P.	H.	{ 340°, 30". In line.
3380	" "	9.1	"	4	5.42	227.12	P.	H.	
3381	" "	9.2	"	4	4.70	228.10	S.	H.	{ 320°, 25".
3382	" "	9.4	"	4	4.35	137.95	S.	H.	
3383	" "	9.6	42 Herculis	4	4.50	138.80	P.	H.	70°, 5".
3384	" "	9.6	"	4	5.57	229.02	P.	H.	300°, 5". [wards.
3385	" "	9.7	"	4	5.88	228.93	S.	H.	300°, 5". Fog after-
3386	Aug. 3	8.2	σ Coronæ A, B . .	4	35.00	227.75	P.	H.	140°, 3". Aug. 3. See-
3387	" "	8.2	" A, B	4	36.77	139.58	P.	H.	[ing 8, 7, 7.
3388	" "	8.5	" A, B	4	34.35	141.60	S.	H.	{ 250°, 3".
3389	" "	8.5	" A, B	4	36.23	227.58	S.	H.	
3390	" "	8.6	" A, C	4	3.75	136.75	P.	H.	135°, 3".
3391	" "	8.6	" A, C	4	6.33	226.98	P.	H.	140°, 8". A out of field.
3392	" "	9.3	" A, C	4	8.72	226.17	S.	H.	300°, 8".
3393	" "	9.3	" A, C	4	3.73	137.03	S.	H.	335°, 8". A out of field.
3394	" "	9.5	ν^2 Coronæ	4	4.45	137.65	P.	H.	140°, 8".
3395	" "	9.5	"	4	4.20	227.40	P.	H.	{ 330°, 30".
3396	" "	9.7	42 Herculis	4	4.40	230.80	S.	H.	
3397	" "	9.7	"	4	4.30	139.90	S.	H.	90°, 4".
3398	" "	9.9	110 Herculis	4	.98	137.97	P.	H.	300°, 4".
3399	" "	10.0	"	4	1.08	227.82	P.	H.	0°, 10".
3400	" "	10.2	"	4	.80	228.50	S.	H.	220°, 8".
3401	" "	10.3	"	4	.98	138.47	S.	H.	175°, 4".
3402	Aug. 5	8.7	σ Coronæ A, C . .	4	5.05	138.50	P.	H.	10°, 5".
3403	" "	8.7	" A, C	4	4.85	228.05	P.	H.	320°, 8".
3404	" "	8.8	" A, C	2	5.10	139.10	S.	H.	150°, 8". [by clouds.
3405	" "	9.3	" A, B	4	30.20	141.00	P.	H.	120°, 8". Interrupted
3406	" "	9.7	" A, B	4	30.40	140.30	P.	H.	40° to 90°, 3". Much de-
3407	" "	9.8	" A, B	4	35.43	231.68	P.	H.	90°, 3". [ayed by clouds
3408	" "	9.9	" A, B	4	35.70	234.55	S.	H.	220°, 3".
3409	Aug. 7	8.1	β Lyræ	4	8.95	140.95	P.	H.	220°, 4".
3410	" "	8.2	"	4	9.47	230.02	P.	H.	120°, 5".
3411	" "	8.3	"	4	11.17	230.83	S.	H.	300°, 5".
3412	" "	8.4	"	4	9.83	141.33	S.	H.	290°, 6".
3413	" "	8.6	σ Coronæ A, C . .	4	8.75	230.95	S.	H.	110°, 6".
3414	" "	8.7	" A, C	4	5.15	141.45	S.	H.	300°, 5". A & B in field.
3415	" "	8.8	" A, C	4	4.30	140.50	P.	H.	100°, 5". [of field.
3416	" "	8.8	" A, C	4	5.85	230.65	P.	H.	120°, 5". A and B out
3417	" "	8.9	" A, B	4	34.22	144.02	S.	H.	310°, 5". Reduced im-
3418	" "	8.9	" A, B	4	34.80	233.85	S.	H.	90°, 3". [ages blurred.
3419	" "	9.0	" A, B	4	37.15	233.90	P.	H.	{ 200°, 3".
3420	" "	9.1	" A, B	4	31.40	143.60	P.	H.	
Total Number . .				17339					80°, 3".

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.	
3421	Aug. 7	9.2	η Draconis . . .	4	4.83	141.67	P.	H.	340°, 3".	
3422	" "	9.3	" . . .	4	3.72	231.27	P.	H.	100°, 3".	
3423	" "	9.3	" . . .	4	3.15	231.50	S.	H.	90°, 3".	
3424	" "	9.4	" . . .	4	3.65	141.45	S.	H.	310°, 3".	
3425	" "	9.7	λ Ursæ Minoris .	4	47.45	225.75	P.	H.	90°, 60". Two images	
3426	" "	9.7	" " .	4	46.97	137.42	P.	H.	90°, 20". of same ob-	
3427	" "	9.7	" " .	4	46.02	136.67	P.	H.	90°, 10". ject com-	
3428	" "	9.8	" " .	4	44.95	139.35	P.	H.	90°, 5". pared to test	
3429	" "	9.8	" " .	4	46.07	140.32	P.	H.	{ 90°, 3". instrument.	
3430	" "	9.8	" " .	4	43.75	154.35	S.	H.		
3431	" "	9.9	" " .	4	44.70	141.30	S.	H.	90°, 5".	
3432	" "	10.0	" " .	4	44.72	138.92	S.	H.	90°, 10".	
3433	" "	10.0	" " .	4	47.80	225.70	S.	H.	90°, 20".	
3434	" "	10.1	" " .	4	45.07	135.42	S.	H.	90°, 60".	
3435	" "	10.6	51 Cephei . . .	4	46.67	226.72	P.	H.	90°, 5". Tests of in-	
3436	" "	10.6	" . . .	4	42.40	137.10	P.	H.	[strument.	
3437	" "	10.7	" . . .	4	44.45	138.70	P.	H.		
3438	" "	10.7	" . . .	4	43.70	137.85	P.	H.	225°, 5".	
3439	" "	10.7	" . . .	4	47.17	138.32	S.	H.	90°, 5".	
3440	" "	10.8	" . . .	4	40.92	136.77	S.	H.	45°, 5".	
3441	" "	10.8	" . . .	4	42.62	139.12	S.	H.	0°, 5".	
3442	" "	10.9	" . . .	4	40.05	138.70	S.	H.	315°, 5".	
3443	" "	11.1	λ Ursæ Minoris .	4	46.27	139.32	P.	H.	0°, 5". Tests of instru-	
3444	" "	11.2	" " .	4	47.42	139.72	P.	H.	[ment.	
3445	" "	11.2	" " .	4	47.97	228.37	P.	H.		
3446	" "	11.2	" " .	4	43.08	138.42	P.	H.	135°, 5".	
3447	" "	11.3	" " .	4	41.85	138.45	P.	H.	180°, 5".	
3448	" "	11.3	" " .	4	42.45	138.30	P.	H.	225°, 5".	
3449	" "	11.4	" " .	4	40.90	138.85	P.	H.	270°, 5".	
3450	" "	11.4	" " .	4	42.42	139.62	P.	H.	315°, 5".	
3451	" "	11.6	Jupiter II, I . . .	4	38.37	225.23	P.	H.	Observations preceding occultation of Jupiter I, to determine the effect on its light of its approach to Jupiter.	
3452	" "	11.6	" II, I . . .	4	41.15	227.05	S.	H.		
3453	" "	11.7	" II, I . . .	4	38.57	226.07	P.	H.		
3454	" "	11.8	" II, I . . .	4	38.70	226.95	P.	H.		
3455	" "	11.9	" II, I . . .	4	38.55	227.65	P.	H.		
3456	" "	12.0	" II, I . . .	4	40.02	226.92	P.	H.		
3457	" "	12.0	" II, I . . .	4	42.03	228.02	P.	H.		[Jupiter.
3458	" "	12.1	" II, I . . .	4	39.00	227.80	P.	H.		Images in contact with
3459	" "	12.1	" II, I . . .	4	37.72	225.47	P.	H.		Satellite half gone.
3460	" "	12.1	" II, I . . .	4	40.17	224.87	P.	H.		
3461	" "	12.8	β Piscis Austrini .	4	9.12	226.72	P.	H.	100°, 6".	
3462	" "	12.9	" " .	4	11.47	136.17	P.	H.	260°, 5".	
3463	" "	13.3	Iapetus	6	1.722		P.	I.	Reappearance of Jupiter I.	
3464	" "	13.5	Titan	5	2.998		P.	I.		
3465	" "	14.0	Iapetus	5	1.228		S.	I.		
3466	" "	14.0	"	5	1.624		P.	I.		
3467	" "	14.6	Jupiter I	7			P.	I.		
3468	" "	14.7	" I	5	1.434		P.	I.		
3469	" "	14.7	" I	5	1.372		P.	I.	[ment.	
3470	Aug. 9	9.7	λ Ursæ Minoris .	4	45.65	142.25	S.	H.	0°, 5". Tests of instru-	
3471	Aug. 11	8.6	DM. + 89° 3 . .	4	47.58	139.12	P.	H.	90°, 5". Tests of in-	
3472	" "	8.7	" . . .	4	50.05	138.55	P.	H.	[strument.	
3473	" "	8.7	" . . .	4	47.47	139.47	P.	H.		
3474	" "	8.8	" . . .	4	44.75	140.05	P.	H.	180°, 5".	
3475	" "	8.9	" . . .	4	45.37	139.37	S.	H.	225°, 5".	
3476	" "	9.0	" . . .	4	47.57	229.12	S.	H.	90°, 5".	
3477	" "	9.1	" . . .	4	48.00	139.55	S.	H.	135°, 5".	
3478	" "	9.1	" . . .	4	43.52	140.42	S.	H.	180°, 5".	
3479	" "	9.2	" . . .	4	16.77	136.22	P.	H.	225°, 5".	
3480	" "	9.2	" . . .	4	16.60	228.20	P.	H.	90°. } Limit of visibility.	
									270°. } Second image out of field.	
Total Number . .				17589						

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3481	Aug. 11	9.3	DM. + 89° 3 . .	4	13.92	227.57	S.	H.	270°. } Limit of visibility.
3482	" "	9.3	" " . .	4	13.62	136.37	S.	H.	Second image out of field.
3483	" "	9.4	α Ursæ Minoris . .	4	.65	227.20	P.	H.	270°. Limit of visibility.
3484	" "	9.5	" " . .	4	.22	137.37	P.	H.	90°. No point of disappearance.
3485	" "	9.5	" " . .	2	.00	46.70	S.	H.	
3486	" "	9.6	" " . .	4	.05	227.75	S.	H.	270°.
3487	" "	9.9	51 Cephei . . .	4	2.82	137.12	P.	H.	90°. Limit of visibility.
3488	" "	9.9	" " . . .	4	3.02	227.32	P.	H.	270°.
3489	" "	10.0	" " . . .	4	2.37	227.47	S.	H.	
3490	" "	10.1	" " . . .	4	2.40	137.40	S.	H.	90°.
3491	" "	10.2	λ Ursæ Minoris . .	4	5.20	227.15	P.	H.	270°. Limit of visibility.
3492	" "	10.2	" " . . .	4	5.55	137.80	P.	H.	90°.
3493	" "	10.2	" " . . .	4	4.25	137.30	S.	H.	
3494	" "	10.3	" " . . .	4	4.80	227.25	S.	H.	270°.
3495	Aug. 12	7.8	λ Ursæ Minoris . .	4	45.77	143.88	P.	H.	90°, 5". Focus 2.05 cms.
3496	" "	7.9	" " . . .	4	47.57	144.77	P.	H.	90°, 5". " 2.15 "
3497	" "	8.0	" " . . .	4	47.32	146.25	P.	H.	90°, 5". " 2.25 "
3498	" "	8.0	" " . . .	4	48.40	145.40	P.	H.	90°, 5". " 2.35 "
3499	" "	8.1	" " . . .	4	47.65	145.25	P.	H.	90°, 5". " 2.45 "
3500	" "	8.5	" " . . .	4	47.17	144.77	S.	H.	90°, 5". " 2.04 "
3501	" "	8.5	" " . . .	4	48.35	143.10	S.	H.	90°, 5". " 2.14 "
3502	" "	8.6	" " . . .	4	46.10	141.90	S.	H.	90°, 5". " 2.24 "
3503	" "	8.7	" " . . .	4	46.45	144.05	S.	H.	90°, 5". " 2.34 "
3504	" "	8.9	" " . . .	4	48.37	141.22	S.	H.	90°, 5". " 2.44 "
3505	" "	9.1	" " . . .	4	44.25	143.15	U.	H.	90°, 5". " 1.91 "
3506	" "	9.2	" " . . .	4	44.82	145.27	U.	H.	90°, 5". " 2.01 "
3507	" "	9.2	" " . . .	4	43.70	143.70	U.	H.	90°, 5". " 2.11 "
3508	" "	9.3	" " . . .	4	45.30	145.20	U.	H.	90°, 5". " 2.21 "
3509	" "	9.3	" " . . .	4	45.35	143.65	U.	H.	90°, 5". " 2.31 "
3510	" "	9.4	" " . . .	4	43.37	142.62	S.	H.	0°, 5". Aug. 12. Seeing
3511	" "	9.5	" " . . .	4	45.40	145.45	S.	H.	45°, 5". [4, 6, 7.
3512	" "	9.5	" " . . .	4	47.17	143.27	S.	H.	90°, 5".
3513	" "	9.5	" " . . .	4	49.15	143.85	S.	H.	135°, 5".
3514	" "	9.6	" " . . .	4	48.22	143.13	S.	H.	180°, 5".
3515	" "	9.7	" " . . .	4	45.32	142.52	S.	H.	225°, 5".
3516	" "	9.7	" " . . .	4	42.92	143.52	S.	H.	270°, 5".
3517	" "	9.7	" " . . .	4	41.50	143.10	S.	H.	315°, 5".
3518	Aug. 14	8.0	λ Ursæ Minoris . .	4	46.45	140.25	U.	H.	90°, 60". Tests of in-
3519	" "	8.1	" " . . .	4	45.00	140.45	U.	H.	90°, 20". [strument.
3520	" "	8.1	" " . . .	4	45.20	141.70	U.	H.	90°, 10".
3521	" "	8.2	" " . . .	4	43.15	141.10	U.	H.	90°, 5".
3522	" "	8.2	" " . . .	4	43.50	141.60	U.	H.	90°, 3".
3523	" "	8.4	" " . . .	4	45.47	140.13	U.	H.	0°, 5".
3524	" "	8.5	" " . . .	4	44.28	140.02	U.	H.	45°, 5".
3525	" "	8.5	" " . . .	4	44.05	141.35	U.	H.	90°, 5".
3526	" "	8.6	" " . . .	4	45.13	141.27	U.	H.	135°, 5".
3527	" "	8.7	" " . . .	4	45.47	138.98	U.	H.	180°, 5".
3528	" "	8.7	" " . . .	4	44.85	141.30	U.	H.	225°, 5".
3529	" "	8.8	" " . . .	4	46.85	140.40	U.	H.	270°, 5".
3530	" "	9.0	" " . . .	4	45.85	141.20	U.	H.	315°, 5".
3531	" "	9.1	DM. + 89° 3 . .	4	42.45	140.10	U.	H.	0°, 5".
3532	" "	9.1	" " . . .	4	44.47	142.37	U.	H.	45°, 5".
3533	" "	9.2	" " . . .	4	42.52	140.22	U.	H.	90°, 5".
3534	" "	9.3	" " . . .	4	47.02	139.17	U.	H.	135°, 5".
3535	" "	9.4	51 Cephei . . .	4	42.92	138.97	U.	H.	0°.
3536	" "	9.5	" " . . .	4	41.50	139.80	U.	H.	45°.
3537	" "	9.5	" " . . .	4	41.75	140.55	U.	H.	90°.
3538	" "	9.5	" " . . .	4	44.82	138.42	U.	H.	135°.
3539	" "	9.7	β Lyræ	4	10.65	228.35	P.	H.	270°, 5". A out of field.
3540	" "	9.8	" "	4	9.07	139.42	P.	H.	110°, 5".
Total Number . .				17827					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3541	Aug. 14	9.9	β Lyræ	4	10.45	138.35	S.	H.	80°, 5".
3542	" "	9.9	"	4	10.17	227.97	S.	H.	220°, 5".
3543	" "	10.3	Iapetus	5	1.492		P.	I.	
3544	" "	10.3	"	5	.954		S.	I.	
3545	" "	10.4	"	5	1.412		U.	I.	
3546	Aug. 18	9.3	110 Herculis . .	5	2.920		P.	I.	
3547	" "	9.4	"	5	3.138		S.	I.	[ter II.
3548	Aug. 19	9.7	Jupiter II . . .	5			P.	I.	Reappearance of Jupi-
3549	" "	9.9	" II	5	2.508		P.	I.	Clouds. Seeing good
3550	" "	10.0	" II	5	2.566		P.	I.	when clear.
3551	Aug. 20	7.7	λ Ursæ Minoris .	4	3.87	233.37	U.	H.	Nos. 3551-3568. Limit
3552	" "	7.8	" "	4	2.73	143.33	U.	H.	of visibility.
3553	" "	8.4	" "	4	2.30	232.40	U.	H.	270°.
3554	" "	8.5	" "	4	2.02	142.67	U.	H.	90°.
3555	" "	8.9	DM. + 89° 3 . .	4	5.20	233.05	U.	H.	90°.
3556	" "	8.9	"	4	5.03	143.08	U.	H.	270°.
3557	" "	9.1	α Ursæ Minoris .	4	.15	142.65	U.	H.	270°. No point of dis-
3558	" "	9.2	" "	4	.20	232.90	U.	H.	[appearance.
3559	" "	9.4	51 Cephei . . .	4	.30	142.55	U.	H.	90°.
3560	" "	9.5	"	4	.30	233.10	U.	H.	270°.
3561	Aug. 22	7.7	λ Ursæ Minoris .	4	3.67	141.97	U.	H.	90°. [8, 5, 5.
3562	" "	7.8	" "	4	3.70	231.60	U.	H.	270°. Aug. 22. Seeing
3563	" "	7.9	α Ursæ Minoris .	4	.05	141.85	U.	H.	90°. No disappearance.
3564	" "	8.0	" "	4	.12	231.98	U.	H.	270°.
3565	" "	8.1	DM. + 89° 3 . .	4	7.48	142.52	U.	H.	90°.
3566	" "	8.2	"	5	5.45	231.50	U.	H.	270°.
3567	" "	8.4	51 Cephei . . .	4	.45	141.45	U.	H.	90°.
3568	" "	8.5	"	4	.65	231.35	U.	H.	270°.
3569	" "	8.9	110 Herculis . .	5	2.246		S.	I.	} Reflected image thought } not to be 110 Herculis.
3570	" "	9.1	"	5	2.536		U.	I.	
3571	" "	9.2	"	5	2.786		S.	I.	
3572	" "	9.3	"	5	3.012		U.	I.	
3573	" "	9.6	η Herculis c . .	5	1.036		S.	I.	
3574	" "	9.7	" B	5	2.380		S.	I.	
3575	" "	9.8	" B	5	2.690		U.	I.	
3576	" "	9.9	" C	5	.936		U.	I.	
3577	Aug. 23	7.5	α Ursæ Minoris .	4	2.50	140.60	U.	H.	0°, 5". Aug. 23. Seeing
3578	" "	7.7	" "	4	2.72	230.72	U.	H.	200°, 5". [8, 5, 4.
3579	" "	8.2	α Andromedæ . .	5	.70	230.60	U.	H.	50°, 6".
3580	" "	8.4	"	4	.58	140.28	U.	H.	230°, 5".
3581	" "	9.5	"	5	2.286		U.	I.	Emergent pencils not
3582	" "	10.0	"	5	2.316		S.	I.	coincident.
3583	" "	11.0	α Lyræ	5	1.286		S.	I.	
3584	" "	11.7	α Ursæ Minoris .	5	4.034		S.	I.	
3585	" "	12.0	" "	5	3.018		S.	I.	Aperture 12.7 cms.
3586	" "	12.4	" "	4	3.12	142.52	S.	H.	80°, 6".
3587	" "	12.5	" "	4	2.60	233.05	S.	H.	300°, 6". [ance.
3588	" "	12.7	α Lyræ	4	.05	232.05	S.	H.	185°, 5". No disappear-
3589	" "	13.1	Jupiter I	11			S.	I.	Reappearance of Jupi-
3590	" "	13.2	" I	5	2.602		S.	I.	ter I.
3591	" "	13.2	" I	5	2.292		S.	I.	
3592	Aug. 25	7.6	Jupiter I	6			S.	I.	} Reappearance of Jupi- } ter I. Seeing 5, 1, 2.
3593	" "	7.7	" I	5	1.796		S.	I.	
3594	Aug. 26	7.5	α Ursæ Minoris .	4	2.70	142.65	U.	H.	0°, 6". Aug. 26. See-
3595	" "	7.6	" "	4	2.95	232.80	U.	H.	210°, 8". [ing 7, 4, 4.
3596	" "	7.9	" "	5	4.278		U.	I.	
3597	" "	8.3	" "	5	2.002		U.	I.	} Aperture 12.7 cms.
3598	" "	8.6	α Andromedæ . .	5	.644		U.	I.	
3599	" "	8.9	"	5	1.874		U.	I.	[able with Phot. I.
3600	" "	9.6	η Draconis . . .	4	4.30	233.15	U.	H.	350°, 3". Not measur-
Total Number . .				18106					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3601	Aug. 26	9.8	η Draconis . . .	4	4.00	142.80	U.	H.	120°, 2".
3602	" "	10.2	α Lyræ . . .	5	1.136		U.	I.	Not meas. with Phot. H.
3603	" "	10.4	" . . .	5	.596		U.	I.	{ Aperture 12.7 cms.
3604	" "	11.1	" . . .	5	.356		S.	I.	
3605	" "	11.4	" . . .	5	1.010		S.	I.	{ Star 250° and 150"
3606	" "	11.6	" . . .	5	.934		S.	I.	
3607	" "	11.7	" . . .	5	.812		U.	I.	{ from α Lyræ.
3608	" "	12.3	Jupiter II . . .	13			S.	I.	
3609	" "	12.4	" II . . .	5	2.892		S.	I.	Reappearance of Jupiter II.
3610	" "	12.4	" II . . .	5	2.534		S.	I.	
3611	Aug. 27	7.1	ζ Ursæ Majoris . . .	4	23.62	142.87	U.	H.	180°, 4". Aug. 27. See-
3612	" "	7.2	" " . . .	4	24.92	233.17	U.	H.	0°, 4". [ing 6, 6, 6.
3613	" "	7.7	ε Draconis . . .	4	15.03	235.42	U.	H.	200°, 2". Clouds.
3614	" "	7.9	" . . .	4	15.45	145.85	U.	H.	90°, 2".
3615	" "	8.2	ε Bootis . . .	4	17.80	146.20	U.	H.	0°, 2".
3616	" "	8.3	" . . .	4	17.52	234.83	U.	H.	210°, 2".
3617	" "	8.5	" . . .	4	19.35	234.30	P.	H.	190°, 2".
3618	" "	8.5	" . . .	4	16.05	144.40	P.	H.	350°, 2".
3619	" "	8.8	η Draconis . . .	4	3.67	233.82	P.	H.	110°, 3". [tinue.
3620	" "	8.9	" . . .	3	8.47	54.77	P.	H.	Seeing too bad to con-
3621	" "	9.5	β Lyræ . . .	4	9.65	230.05	U.	H.	100°, 4". A out of field.
3622	" "	9.5	" . . .	4	9.10	140.10	U.	H.	250°, 4".
3623	Aug. 28	7.9	ζ Ursæ Majoris . . .	4	24.20	139.50	P.	H.	190°, 5".
3624	" "	7.9	" " . . .	4	24.67	229.77	P.	H.	10°, 5".
3625	" "	8.0	" " . . .	4	24.05	231.95	U.	H.	5°, 6".
3626	" "	8.0	" " . . .	4	24.55	141.15	U.	H.	150°, 6".
3627	Aug. 29	7.0	12 Canum Venat. . .	4	15.00	230.50	P.	H.	80°, 5". Aug. 29. See-
3628	" "	7.1	" " . . .	4	15.55	140.00	P.	H.	270°, 5". [ing 6, 3, 6.
3629	" "	7.1	" " . . .	4	17.50	139.20	U.	H.	250°, 5".
3630	" "	7.2	" " . . .	4	16.97	230.08	U.	H.	90°, 5".
3631	" "	7.2	ζ Ursæ Majoris . . .	4	23.35	230.80	P.	H.	0°, 5".
3632	" "	7.3	" " . . .	4	28.47	141.02	P.	H.	150°, 5".
3633	" "	7.4	" " . . .	4	26.47	143.37	P.	H.	180°, 5".
3634	" "	7.4	" " . . .	4	24.67	231.57	P.	H.	350°, 5".
3635	" "	7.5	" " . . .	4	25.20	231.50	U.	H.	355°, 6".
3636	" "	7.5	" " . . .	4	24.00	142.70	U.	H.	180°, 4".
3637	" "	7.6	12 Canum Venat. . .	4	17.70	140.50	P.	H.	270°, 5".
3638	" "	7.6	" " . . .	4	16.58	230.03	P.	H.	90°, 5".
3639	" "	7.7	" " . . .	4	17.60	231.75	U.	H.	90°, 5".
3640	" "	7.7	" " . . .	4	16.68	141.38	U.	H.	270°, 5".
3641	" "	7.9	α Ursæ Minoris . . .	4	2.67	231.68	P.	H.	20°, 5". Images of A 18".
3642	" "	7.9	" " . . .	4	.80	140.80	P.	H.	130°, 5". " of A 60".
3643	" "	8.0	" " . . .	4	1.65	141.50	P.	H.	150°, 5". " of A 40".
3644	" "	8.1	" " . . .	4	2.60	142.05	P.	H.	210°, 5". " of A 18".
3645	" "	8.1	" " . . .	4	3.17	142.38	P.	H.	310°. " of A 10".
3646	" "	8.2	" " . . .	4	4.07	142.93	P.	H.	" of A 5".
3647	" "	8.3	" " . . .	4	2.55	142.20	U.	H.	210°, 5". " of A 18".
3648	" "	8.4	" " . . .	4	1.10	230.45	U.	H.	110°. " of A 60".
3649	" "	8.5	" " . . .	4	1.70	230.50	U.	H.	" of A 40".
3650	" "	8.5	" " . . .	4	3.20	230.75	U.	H.	10°, 5". " of A 18".
3651	" "	8.6	" " . . .	4	3.87	231.38	U.	H.	" of A 10".
3652	" "	8.7	" " . . .	4	5.15	231.75	U.	H.	" of A 5".
3653	" "	9.0	DM. + 89° 3 . . .	4	13.95	139.80	P.	H.	90°. }
3654	" "	9.1	" " . . .	4	15.85	229.55	P.	H.	270°. }
3655	" "	9.2	λ Ursæ Minoris . . .	4	5.65	140.70	P.	H.	90°. }
3656	" "	9.2	" " . . .	4	5.07	230.27	P.	H.	270°. }
3657	" "	9.3	51 Cephei . . .	4	2.65	139.90	P.	H.	90°. }
3658	" "	9.4	" " . . .	4	2.83	230.23	P.	H.	270°. }
3659	" "	9.8	Iapetus . . .	5	1.716		P.	I.	In No. 3645, reading 228.4 was recorded 218.4.
3660	" "	9.9	" . . .	5	1.448		U.	I.	
Total Number . .				18364					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3661	Aug. 29	10.2	Rhea, Titan . . .	4	28.72	229.72	U.	H.	Titan near Saturn, apparently no brighter than Rhea.
3662	" "	10.4	" " . . .	4	28.82	227.72	P.	H.	
3663	Aug. 30	7.3	12 Canum Venat. .	4	17.75	230.75	U.	H.	90°, 5". Aug. 30. Seeing 6, 6, 8.
3664	" "	7.4	" " . . .	4	16.25	141.20	U.	H.	
3665	" "	7.5	" " . . .	4	17.45	141.30	P.	H.	250°, 5".
3666	" "	7.5	" " . . .	4	15.60	231.75	P.	H.	
3667	" "	7.6	" " . . .	4	15.78	230.47	P.	H.	100°, 5".
3668	" "	7.6	" " . . .	4	18.38	139.58	P.	H.	
3669	" "	7.7	" " . . .	4	15.70	142.85	U.	H.	250°, 5".
3670	" "	7.7	" " . . .	4	17.20	230.35	U.	H.	
3671	" "	7.8	ζ Ursæ Majoris . .	4	25.10	139.10	P.	H.	160°, 5". Aperture 12.7 cms.
3672	" "	7.9	" " . . .	4	24.32	232.23	P.	H.	
3673	" "	8.0	" " . . .	4	23.25	232.45	U.	H.	350°, 5".
3674	" "	8.0	" " . . .	4	20.77	140.63	U.	H.	
3675	" "	8.2	η Draconis . . .	4	3.97	143.38	P.	H.	340°, 3". Images very steady; very unsteady in previous observation.
3676	" "	8.3	" " . . .	4	4.70	232.60	P.	H.	
3677	" "	8.4	" " . . .	4	3.30	232.85	U.	H.	130°, 3".
3678	" "	8.5	" " . . .	4	3.38	143.22	U.	H.	
3679	" "	8.6	ε Bootis . . .	4	21.08	233.73	P.	H.	220°, 3".
3680	" "	8.7	" " . . .	4	17.42	144.83	P.	H.	
3681	" "	8.8	" " . . .	4	16.45	144.85	U.	H.	355°, 3".
3682	" "	8.8	" " . . .	4	17.20	235.30	U.	H.	
3683	" "	9.6	β Lyræ . . .	4	12.35	141.05	P.	H.	190°, 5".
3684	" "	9.7	" " . . .	4	12.35	229.85	P.	H.	
3685	" "	9.7	" " . . .	4	14.03	230.42	U.	H.	{ 20°, 5".
3686	" "	9.8	" " . . .	4	12.30	139.60	U.	H.	
3687	" "	9.9	η Lyræ . . .	4	8.67	141.32	P.	H.	340°, 5".
3688	" "	9.9	" " . . .	4	8.35	231.20	P.	H.	
3689	" "	10.0	" " . . .	4	9.23	230.70	U.	H.	110°, 5".
3690	" "	10.0	" " . . .	4	8.15	141.30	U.	H.	
3691	Aug. 31	9.5	Iapetus . . .	5	1.298		P.	I.	Seeing 4, 6, 7.
3692	Sept. 1	7.1	η Lyræ . . .	4	7.55	142.45	P.	H.	
3693	" "	7.2	" " . . .	4	7.50	232.25	P.	H.	250°, 5".
3694	" "	7.2	β Cygni . . .	4	18.30	231.50	P.	H.	
3695	" "	7.3	" " . . .	4	18.97	140.92	P.	H.	210°, 5".
3696	" "	7.4	" " . . .	4	21.95	139.95	P.	H.	
3697	" "	7.5	" " . . .	4	21.45	232.45	P.	H.	30°, 5". Aperture 12.7 cms.
3698	" "	7.6	η Lyræ . . .	4	8.53	231.48	P.	H.	
3699	" "	7.6	" " . . .	4	8.45	142.20	P.	H.	40°, 5".
3700	" "	8.1	α Ursæ Minoris . .	4	2.60	141.90	P.	H.	
3701	" "	8.2	" " . . .	4	2.80	231.70	P.	H.	220°, 5".
3702	" "	8.2	" " . . .	4	2.30	230.55	P.	H.	
3703	" "	8.3	" " . . .	4	2.12	140.52	P.	H.	30°, 5". Reflected image.
3704	" "	8.3	" " . . .	4	2.25	230.35	P.	H.	
3705	" "	9.4	Jupiter . . .	5	.458		P.	I.	Limit of visibility.
3706	" "	9.5	" I . . .	13			P.	I.	
3707	" "	9.6	" I . . .	5	3.304		P.	I.	Reappearance of Jupiter I.
3708	" "	9.7	" I . . .	5	3.136		P.	I.	
3709	" "	10.0	Iapetus . . .	5	1.584		P.	I.	Reappearance of Jupiter IV. Clouds and haze.
3710	" "	10.6	Jupiter IV, I . . .	16			P.	H.	
3711	" "	10.7	" IV, I . . .	10	33.57	52.83	P.	H.	Limit of visibility.
3712	" "	10.8	" IV, I . . .	10	35.79	51.79	P.	H.	
3713	" "	10.9	" I . . .	5	10.65	48.35	P.	H.	90°, 8". A out of field.
3714	Sept. 2	7.9	α Cassiopeiæ . . .	4	2.22	141.07	P.	H.	
3715	" "	7.9	" " . . .	4	3.15	230.90	P.	H.	260°, 8". Sept. 2. Seeing 4, 7, 5.
3716	" "	8.0	" " . . .	4	3.85	231.15	U.	H.	
3717	" "	8.1	" " . . .	4	2.95	140.70	U.	H.	90°, 8".
3718	" "	8.5	β Cygni . . .	4	26.33	231.78	S.	H.	
3719	" "	8.7	" " . . .	4	18.72	142.37	S.	H.	0°, 5". At long interv., through and between clouds.
3720	" "	8.8	" " . . .	4	19.50	142.30	U.	H.	
Total Number . .				18643					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3721	Sept. 2	8.9	β Cygni	4	21.92	232.52	U.	H.	300°, 6".
3722	" "	9.2	"	4	19.10	141.40	S.	H.	100°, 5".
3723	" "	9.2	"	4	22.30	231.70	S.	H.	290°, 5".
3724	" "	9.3	"	4	20.63	231.38	U.	H.	300°, 7".
3725	" "	9.4	"	4	21.55	142.45	U.	H.	140°, 5".
3726	" "	10.1	β Lyrae	4	9.02	231.88	U.	H.	10°, 5".
3727	" "	10.2	"	4	9.32	141.27	U.	H.	190°, 5".
3728	Sept. 6	7.4	α Librae	4	26.15	236.55	S.	(H.)	270°, 10".
3729	" "	7.5	"	4	25.95	144.40	S.	(H.)	270°, 5".
3730	" "	7.5	"	4	19.50	145.60	U.	(H.)	270°, 5".
3731	" "	7.6	"	4	21.05	237.50	U.	(H.)	270°, 8".
3732	" "	7.7	"	4	21.18	235.67	P.	(H.)	270°, 10".
3733	" "	7.8	"	4	19.93	146.13	P.	(H.)	270°, 5".
3734	" "	8.0	12 Canum Venat. .	4	21.38	149.13	U.	(H.)	100°, 4".
3735	" "	8.1	" " .	4	17.25	238.55	U.	(H.)	250°, 4".
3736	" "	8.1	" " .	4	18.00	240.50	P.	(H.)	250°, 3".
3737	" "	8.2	" " .	4	16.07	149.72	P.	(H.)	120°, 3".
3738	" "	8.5	α Cassiopeiæ . .	4	2.95	236.15	P.	H.	100°, 10".
3739	" "	8.5	"	4	2.93	146.07	P.	H.	280°, 10".
3740	" "	8.6	"	4	2.72	146.07	U.	H.	270°, 5".
3741	" "	8.7	"	4	3.45	236.00	U.	H.	100°, 5".
3742	" "	9.4	Jupiter, R 3 . . .	5	1.084		P.	I.	} For constant.
3743	" "	9.5	" R 3	5	.886		U.	I.	
3744	" "	9.5	" R 3	5	1.412		S.	I.	
3745	" "	9.8	Iapetus	5	.866		P.	I.	
3746	" "	9.9	"	5	.572		S.	I.	
3747	" "	9.9	"	5	.908		U.	I.	
3748	Sept. 7	9.9	Iapetus	5	1.006		P.	I.	Sept. 7. Seeing 4, 6, 4.
3749	" "	10.0	Hyperion	5	.584		P.	I.	
3750	" "	10.1	"	5	.436		S.	I.	
3751	" "	10.2	Iapetus	5	.720		S.	I.	
3752	" "	7.2	α Librae	4	18.72	149.62	S.	(H.)	280°, 6".
3753	Sept. 8	7.2	α Librae	4	18.18	145.83	S.	(H.)	280°, 6". B elongated.
3754	" "	7.3	"	4	20.80	145.40	P.	(H.)	280°, 6".
3755	" "	7.3	"	4	21.10	237.00	S.	(H.)	280°, 10". A elongated.
3756	" "	7.4	"	4	20.83	236.32	P.	(H.)	280°, 10".
3757	" "	7.5	12 Canum Venat. .	4	17.80	238.05	P.	(H.)	110°, 5".
3758	" "	7.5	" " .	4	19.33	237.57	S.	(H.)	110°, 4".
3759	" "	7.6	" " .	4	16.87	147.22	P.	(H.)	250°, 3".
3760	" "	7.7	" " .	4	18.88	147.87	S.	(H.)	240°, 3".
3761	" "	9.3	α Andromedæ . .	4	.62	234.33	P.	H.	70°, 10".
3762	" "	9.4	"	4	.33	144.40	P.	H.	Sept. 8. Seeing 70°, 10".
3763	" "	9.7	"	4	.75	144.80	P.	H.	No disappearance.
3764	" "	9.8	"	5	2.566		P.	I.	
3765	" "	9.9	"	5	.934		P.	I.	Aperture 12.7 cms.
3766	" "	10.1	α Cassiopeiæ . .	5	2.316		P.	I.	Aperture 12.7 cms.
3767	" "	10.3	"	4	2.20	145.20	P.	H.	90°, 10".
3768	" "	10.3	"	4	3.33	234.87	P.	H.	20°, 5".
3769	" "	10.4	"	4	2.97	234.67	S.	H.	20°, 8".
3770	" "	10.5	"	4	2.72	145.23	S.	H.	20°, 5".
3771	" "	10.8	Iapetus	5	1.176		P.	I.	Emergent pencils not coincident.
3772	" "	10.8	"	5	1.160		P.	I.	
3773	" "	10.9	"	5	.832		S.	I.	
3774	" "	11.3	Jupiter	5	.404		S.	I.	Limit of visibility.
3775	" "	11.5	" I	7			S.	I.	Reappearance of Jupiter I.
3776	" "	11.5	" I	5	2.308		S.	I.	
3777	" "	11.6	" I	5	2.548		S.	I.	
3778	Sept. 9	7.9	Jupiter I	4	44.08	147.63	P.	H.	} See note following.
3779	" "	7.9	" I	4	42.05	145.70	P.	H.	
3780	" "	8.0	" I	4	44.95	146.05	P.	H.	
Total Number . .				18905					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3781	Sept. 9	8.2	Jupiter I	4	46.65	144.85	P.	H.	One image of Jupiter I. coincident with one of its shadow on Jupiter, and compared with disk surrounding. Seeing bad.
3782	" "	8.2	" I	4	43.55	142.10	P.	H.	
3783	" "	8.3	" I	4	47.95	146.35	P.	H.	
3784	" "	8.4	" I	4	35.05	145.65	P.	H.	
3785	" "	8.5	" I	4	41.65	143.75	P.	H.	
3786	" "	8.7	" IV, I	4	38.17	144.37	P.	H.	Jupiter IV. on disk of [Jupiter.
3787	" "	8.8	Jupiter, R 3	5	1.202		P.	I.	} For constant.
3788	" "	8.9	" R 3	5	1.480		S.	I.	
3789	" "	9.0	" R 3	5	1.420		U.	I.	
3790	" "	9.3	α Andromedæ	5	3.084		P.	I.	} Aperture 12.7 cms. Clouds at times. α Cassiopeiæ not measurable with full aperture.
3791	" "	9.4	"	5	3.002		S.	I.	
3792	" "	9.5	"	5	1.308		S.	I.	
3793	" "	9.6	"	5	1.032		P.	I.	
3794	" "	9.7	α Cassiopeiæ	5	2.906		P.	I.	
3795	" "	9.8	"	5	3.832		S.	I.	} 180°, 5". 30°, 5". 30°, 7". 180°, 5". Clouds. 45°, 5". 270°, 7". 80°, 7". Focus unsatisfactory. 140°, 5". 330°, 5".
3796	" "	10.3	Iapetus	5	.658		S.	I.	
3797	" "	10.3	"	5	.746		P.	I.	
3798	" "	10.4	"	5	.872		U.	I.	
3799	" "	9.0	ζ Ursæ Majoris	4	26.47	236.52	P.	(H.)	
3800	" "	9.1	" "	4	23.15	145.60	P.	(H.)	} Disappearance of Jupiter III. Clouds interfered with observations.
3801	" "	9.2	β Capricorni	4	15.42	146.03	U.	(H.)	
3802	" "	9.3	" "	4	12.70	235.65	U.	(H.)	
3803	" "	9.5	ζ Ursæ Majoris	6	23.30	148.05	U.	(H.)	
3804	" "	9.6	" "	4	28.58	238.27	U.	(H.)	
3805	" "	9.9	η Lyræ	4	42.53	145.13	U.	(H.)	} Reappearance of Jupiter III.
3806	" "	10.0	"	4	43.35	149.35	U.	(H.)	
3807	Sept. 10	7.7	β Cygni	4	19.50	236.15	P.	H.	
3808	" "	7.7	"	4	20.40	146.10	P.	H.	
3809	" "	8.1	Jupiter I, III	4	49.45	144.85	P.	H.	
3810	" "	8.1	" I, III	4	48.02	147.47	P.	H.	} Limit of visibility. 240°, 6". 110°, 4".
3811	" "	8.3	" I, III	6			P.	H.	
3812	" "	12.1	" I, III	12			P.	H.	
3813	" "	12.4	" I, III	4	47.67	60.25	P.	H.	
3814	" "	12.4	" I, III	4	47.17	59.77	P.	H.	
3815	" "	12.4	" I	4	22.17	58.92	P.	H.	} Reappearance of Jupiter III. Clouds.
3816	" "	7.2	12 Canum Venat. . . .	4	17.47	148.93	U.	(H.)	
3817	" "	7.3	" "	4	20.90	235.90	U.	(H.)	
3818	" "	12.2	Jupiter III	4			S.	(I.)	
3819	" "	12.3	" III	5	1.688		S.	(I.)	
3820	" "	12.4	" III	5	1.810		S.	(I.)	} 0°, 5". 120°, 5". 150°, 3". 300°, 3". 260°, 5". 135°, 5". 350°, 4". 220°, 4".
3821	Sept. 12	7.4	β Cygni	4	18.23	145.33	U.	(H.)	
3822	" "	7.6	"	4	21.42	235.93	U.	(H.)	
3823	" "	7.9	ϵ Draconis	4	13.72	150.97	P.	H.	
3824	" "	8.1	"	4	15.23	238.47	P.	H.	
3825	" "	8.1	"	4	13.45	239.90	S.	H.	} Sept. 14. Seeing 4, 4, 3.
3826	" "	8.2	"	4	14.27	147.67	S.	H.	
3827	" "	8.5	ϵ Bootis	4	16.40	153.45	S.	H.	
3828	" "	8.7	"	4	21.17	240.53	S.	H.	
3829	Sept. 14	8.4	12 Canum Venat. . . .	4	16.87	146.67	S.	H.	
3830	" "	8.5	" "	4	17.45	236.30	S.	H.	} Aperture 12.7 cms.
3831	" "	8.7	" "	4	14.20	236.75	S.	H.	
3832	" "	8.8	" "	4	15.57	146.27	S.	H.	
3833	" "	8.9	ζ Ursæ Majoris	4	25.97	149.18	S.	H.	
3834	" "	9.1	" "	4	24.95	238.70	S.	H.	
3835	" "	9.2	" "	4	25.35	239.30	S.	H.	} No decided disap. A out of field.
3836	" "	9.2	" "	4	27.03	146.97	S.	H.	
3837	" "	9.8	Iapetus	5	.614		S.	I.	
3838	" "	9.9	"	5	.720		P.	I.	
3839	" "	10.2	α Andromedæ	6	.53	145.88	S.	H.	
3840	" "	10.3	"	4	.97	236.12	S.	H.	
Total Number				19175					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3841	Sept. 14	10.4	α Andromedæ . . .	4	.87	235.82	P.	H.	290°, 4". [ance.
3842	" "	10.5	"	6	.20	145.97	P.	H.	70°, 4". No disappear-
3843	Sept. 15	3.4	Sky	12			S.	I.	To find effect of ob- ject-glass, which was removed after first two sets, cleaned, and replaced after next two.
3844	" "	3.7	"	12			P.	I.	
3845	" "	4.2	"	12			S.	I.	
3846	" "	4.5	"	12			P.	I.	
3847	" "	5.3	"	12			S.	I.	
3848	" "	5.6	"	12			P.	I.	
3849	" "	8.1	β Cygni	4	21.50	145.20	P.	H.	150°, 5". Sept. 15. See-
3850	" "	8.2	"	4	19.38	237.23	P.	H.	20°, 5". [ing 4, 5, 4.
3851	" "	8.3	η Lyræ	4	6.80	237.20	P.	H.	150°, 6".
3852	" "	8.4	"	4	9.67	147.13	P.	H.	0°, 6". Very faint.
3853	" "	8.6	"	4	12.05	148.00	S.	H.	300°, 6".
3854	" "	8.7	"	4	8.75	236.50	S.	H.	{ 90°, 5".
3855	" "	8.8	β Cygni	4	20.25	236.05	S.	H.	
3856	" "	8.9	"	4	21.12	147.12	S.	H.	290°, 5".
3857	" "	9.2	α Lyræ	5	.458		P.	I.	Nos. 3849-3859. Aper- ture 12.7 cms.
3858	" "	9.3	"	5	.426		S.	I.	
3859	" "	9.5	α Andromedæ . . .	5	1.060		S.	I.	
3860	" "	9.7	Iapetus	5	.590		S.	I.	
3861	" "	9.8	"	5	.684		P.	I.	
3862	" "	9.9	β Piscis Austrini .	4	12.32	237.42	P.	H.	260°, 5".
3863	" "	9.9	"	4	10.45	148.55	P.	H.	{ 100°, 5".
3864	" "	10.0	"	4	12.27	147.93	S.	H.	
3865	" "	10.0	"	4	12.85	237.55	S.	H.	250°, 5".
3866	Sept. 16	8.5	ϵ Draconis	4	14.30	239.00	S.	H.	270°, 3". Sept. 16. See-
3867	" "	8.6	"	4	17.90	148.80	S.	H.	135°, 3". [ing 4, 5, 5.
3868	" "	8.8	η Lyræ	4	10.77	237.62	S.	H.	90°, 5".
3869	" "	8.8	"	4	8.70	148.10	S.	H.	290°, 5".
3870	" "	8.9	"	4	9.85	147.30	U.	H.	280°, 6".
3871	" "	9.0	"	4	8.98	236.88	U.	H.	90°, 5".
3872	" "	9.1	"	4	8.30	237.30	U.	H.	90°, 5".
3873	" "	9.1	"	4	9.33	146.42	U.	H.	280°, 5".
3874	" "	9.2	"	4	10.00	146.25	S.	H.	280°, 4".
3875	" "	9.3	"	4	8.60	236.15	S.	H.	90°, 5".
3876	" "	9.6	α Cassiopeiæ . . .	5	3.250		S.	I.	{ Aperture 12.7 cms.
3877	" "	9.7	"	5	2.852		U.	I.	
3878	" "	10.0	Iapetus	5	.598		S.	I.	
3879	" "	10.1	"	5	.716		U.	I.	
3880	" "	10.2	"	5	.744		P.	I.	
3881	" "	7.9	ϵ Pegasi	4	3.90	235.20	U.	(H.)	120°, 4". A out of field.
3882	" "	8.0	"	4	3.65	145.95	U.	(H.)	270°, 6".
3883	" "	9.5	ζ Ursæ Majoris . .	4	26.05	153.30	P.	(H.)	150°, 5".
3884	" "	9.6	"	4	25.67	148.83	P.	(H.)	190°, 5".
3885	" "	9.8	β Capricorni . . .	4	14.98	235.07	P.	(H.)	190°, 5". A out of field.
3886	" "	9.9	"	4	17.12	145.22	P.	(H.)	30°, 5".
3887	Sept. 17	7.0	β Cygni	4	18.38	147.02	U.	H.	200°, 5". Sept. 17. See-
3888	" "	7.1	"	4	22.92	237.93	U.	H.	45°, 5". [ing 4, 5, 5.
3889	" "	7.2	ϵ Draconis	4	14.05	238.80	P.	H.	120°, 3".
3890	" "	7.3	"	4	15.88	147.17	P.	H.	260°, 2".
3891	" "	7.8	Jupiter I, III . . .	10			S.	H.	[ter I. Reappearance of Jupi-
3892	" "	7.9	"	6	45.85	146.98	S.	H.	[tation.
3893	" "	7.9	"	4	43.50	150.40	S.	H.	
3894	" "	8.4	α Andromedæ . . .	4	.75	146.30	U.	H.	Jupiter III. near occul-
3895	" "	8.5	"	4	1.10	236.50	U.	H.	90°, 5". A out of field.
3896	" "	8.9	Iapetus	5	.562		S.	I.	270°, 5".
3897	" "	9.0	"	5	.736		P.	I.	
3898	" "	9.1	"	5	.752		U.	I.	
3899	" "	9.3	β Piscis Austrini .	4	10.70	238.25	U.	H.	270°, 6". A in field.
3900	" "	9.4	"	4	10.75	149.42	U.	H.	100°, 6".
Total Number . . .				19486					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3901	Sept. 17	9.4	β Piscis Austrini .	4	8.85	148.95	S.	H.	100°, 6".
3902	" "	9.5	" "	4	12.43	239.82	S.	H.	270°, 6".
3903	" "	9.7	α Lyræ	5	1.196		P.	I.	
3904	" "	9.8	" "	5	.512		P.	I.	Aperture 12.7 cms.
3905	" "	7.9	Jupiter I	5			P.	(I.)	Reappearance of Jupiter I.
3906	" "	7.9	" I	5	2.052		P.	(I.)	
3907	" "	8.2	" "	5	.632		P.	(I.)	Limit of visibility.
3908	Sept. 18	6.9	σ Coronæ A, B . .	4	30.80	151.65	P.	H.	80°, 3". Sept. 18. See-
3909	" "	7.0	" A, B	4	36.18	151.72	P.	H.	220°, 3". [ing 7, 7, 7.
3910	" "	7.0	" A, B	4	32.85	150.80	U.	H.	210°, 3".
3911	" "	7.1	" A, B	4	35.83	150.77	U.	H.	90°, 3".
3912	" "	7.2	" A, C	4	7.05	236.40	U.	H.	30°, 5". A out of field.
3913	" "	7.2	" A, C	4	6.65	146.30	U.	H.	340°, 5".
3914	" "	7.3	" A, C	4	4.95	146.55	P.	H.	330°, 5".
3915	" "	7.3	" A, C	4	5.38	236.72	P.	H.	100°, 5".
3916	" "	7.7	α Lyræ	5	1.572		P.	I.	{ At settings 1.00 and 1.10 B much brighter than A.
3917	" "	7.8	" "	5	1.656		U.	I.	
3918	" "	8.1	" "	5	1.340		S.	I.	
3919	" "	8.3	β Lyræ	4	11.35	146.05	U.	H.	200°, 4". A out of field.
3920	" "	8.3	" "	4	11.55	236.80	U.	H.	30°, 4". [best in focus.
3921	" "	8.4	" "	4	10.83	236.17	S.	H.	20°, 4". Reduced image
3922	" "	8.5	" "	4	13.20	147.80	S.	H.	180°, 5". B best in focus.
3923	" "	9.0	η Herculis B . .	5	3.134		U.	I.	
3924	" "	9.1	" C	5	1.140		U.	I.	
3925	" "	9.2	" C	5	1.278		P.	I.	
3926	" "	9.2	" B	5	3.212		P.	I.	
3927	" "	10.1	Iapetus	5	.644		P.	I.	
3928	" "	10.2	" "	5	.720		S.	I.	
3929	" "	10.3	" "	5	.758		U.	I.	
3930	" "	9.0	ζ Ursæ Majoris .	4	28.80	236.25	S.	(H.)	30°, 4".
3931	" "	9.1	" "	5	25.05	146.85	S.	(H.)	175°, 4".
3932	" "	9.8	β Capricorni . .	4	14.72	235.57	S.	(H.)	340°, 4". } Images faint.
3933	" "	9.9	" "	4	18.72	144.48	S.	(H.)	170°, 5". }
3934	Sept. 19	6.3	β Lyræ	4	11.85	238.50	P.	H.	340°, 5". A out of field.
3935	" "	6.4	" "	4	12.22	148.62	P.	H.	200°, 5".
3936	" "	7.7	β Capricorni c . .	5	1.720		P.	I.	A out of field, B in field.
3937	" "	7.8	" c	5	1.678		U.	I.	Relative focus altered, B in field.
3938	" "	7.9	η Herculis c . . .	5	1.434		P.	I.	
3939	" "	8.0	" B	5	3.626		P.	I.	Sept. 19. Seeing 7, 7, 8.
3940	" "	9.0	β Delphini B . . .	5	2.520		P.	I.	
3941	" "	9.1	" B	5	2.344		S.	I.	{ Aperture 12.7 cms.
3942	" "	9.3	δ Equulei	5	4.736		U.	I.	
3943	" "	9.4	" "	5	4.388		S.	I.	
3944	" "	10.0	Iapetus	5	.954		U.	I.	
3945	" "	10.0	" "	5	.846		S.	I.	
3946	" "	10.1	" "	5	.872		P.	I.	
3947	" "	7.0	ζ Ursæ Majoris .	4	27.62	243.83	U.	(H.)	0°, 3".
3948	" "	7.1	" "	4	23.00	154.55	U.	(H.)	
3949	" "	7.3	ϵ Pegasi	4	3.17	151.72	U.	(H.)	90°, 8".
3950	" "	7.5	" "	4	3.93	241.82	U.	(H.)	270°, 8".
3951	" "	8.3	" "	4	3.27	245.52	P.	(H.)	80°, 10".
3952	" "	8.4	" "	4	3.73	155.03	P.	(H.)	300°, 10".
3953	" "	8.5	β Capricorni . . .	4	11.50	150.10	P.	(H.)	190°, 10".
3954	" "	8.6	" "	4	15.30	240.95	P.	(H.)	
3955	" "	8.7	11, 12 Camelopard.	4	37.13	154.27	P.	(H.)	150°, 5".
3956	" "	8.8	" "	4	37.68	150.02	P.	(H.)	320°, 5".
3957	Sept. 20	6.9	α Aquilæ	5	2.364		U.	I.	
3958	" "	7.0	" "	5	2.594		P.	I.	
3959	" "	7.1	β Aquilæ c	5	2.308		P.	I.	{ Probably γ Aquilæ.
3960	" "	7.2	" c	5	1.732		U.	I.	
Total Number . .				19757					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
3961	Sept. 20	7.9	δ Equulei . . .	5	2.930		P.	I.	} Aperture 12.7 cms.
3962	" "	8.0	" . . .	5	4.092		U.	I.	
3963	" "	8.3	β Delphini B . . .	5	2.358		U.	I.	
3964	" "	8.4	" B . . .	5	2.106		S.	I.	
3965	" "	9.4	Jupiter III . . .	8	5.37	238.36	P.	H.	Limit of visibility.
3966	" "	9.5	" II, III . . .	18			P.	H.	Reappearance of Jupiter II., definition bad, III. sometimes double.
3967	" "	9.5	" II, III . . .	4	33.02	236.83	P.	H.	
3968	" "	9.5	" II, III . . .	4	31.07	239.32	P.	H.	
3969	" "	9.5	" II, III . . .	4	31.12	237.92	P.	H.	
3970	" "	10.5	Hyperion . . .	5	.608		P.	I.	
3971	" "	10.6	" . . .	5	.406		U.	I.	
3972	" "	10.7	Iapetus . . .	5	.920		U.	I.	
3973	" "	10.7	" . . .	5	.930		P.	I.	
3974	" "	8.3	β Cygni . . .	4	18.88	150.82	P.	(H.)	130°, 5".
3975	" "	8.4	" . . .	4	20.20	240.50	P.	(H.)	330°, 5".
3976	" "	8.5	ϵ Pegasi . . .	4	4.57	238.72	P.	(H.)	290°, 10". A out of field.
3977	" "	8.5	" . . .	4	3.27	149.13	P.	(H.)	60°, 10".
3978	" "	9.1	" . . .	4	4.43	148.57	S.	(H.)	50°, 5". } A out of field.
3979	" "	9.2	" . . .	4	4.45	238.65	S.	(H.)	270°, 5". }
3980	" "	9.4	Jupiter II . . .	3			S.	(I.)	Reappearance of Jupiter II.
3981	" "	9.4	" II . . .	5	1.158		S.	(I.)	
3982	" "	9.5	" II . . .	5	1.210		S.	(I.)	
3983	Sept. 22	6.9	α Ursæ Minoris . . .	5	4.182		P.	I.	Sept. 22. Seeing 7, 5, 3.
3984	" "	6.9	" " . . .	5	4.368		S.	I.	Some light perhaps cut off from prism.
3985	" "	7.1	" " . . .	5	5.192		S.	I.	
3986	" "	7.2	" " . . .	5	2.418		S.	I.	} Aperture 12.7 cms. Setting 4.16 rejected in first set.
3987	" "	7.2	" " . . .	5	1.882		P.	I.	
3988	" "	7.6	δ Equulei . . .	5	3.438		P.	I.	
3989	" "	7.9	β Delphini B . . .	5	1.710		P.	I.	
3990	" "	8.1	γ Equulei . . .	5	2.764		P.	I.	
3991	" "	8.2	" . . .	5	2.936		S.	I.	
3992	" "	8.4	β Aquilæ . . .	5	2.552		P.	I.	Reflected image visible at 1.10.
3993	" "	8.6	" . . .	5	2.440		S.	I.	
3994	" "	8.8	α Aquilæ . . .	5	1.428		S.	I.	
3995	" "	8.9	" . . .	5	1.338		P.	I.	B perhaps too close to prism.
3996	" "	9.3	Iapetus . . .	5	.766		P.	I.	
3997	" "	9.3	" . . .	5	.630		S.	I.	
3998	" "	9.4	α Arietis . . .	5	1.496		P.	I.	
3999	" "	9.5	" . . .	5	1.456		S.	I.	
4000	Sept. 23	6.5	α Ursæ Minoris . . .	5	4.868		P.	I.	
4001	" "	7.0	μ Sagittarii D . . .	5	3.746		U.	I.	
4002	" "	7.0	" D . . .	5	3.948		S.	I.	
4003	" "	7.3	21 Sagittarii . . .	4	17.68	242.77	P.	H.	Seeing worse.
4004	" "	7.4	" . . .	4	11.35	153.30	P.	H.	
4005	" "	7.8	γ Equulei . . .	5	4.752		U.	I.	
4006	" "	7.9	ϵ Pegasi D . . .	5	1.366		P.	I.	
4007	" "	8.0	" D . . .	5	1.334		U.	I.	
4008	" "	8.1	β Aquilæ . . .	5	2.818		P.	I.	
4009	" "	8.2	" . . .	5	1.768		U.	I.	
4010	" "	8.6	α Delphini E . . .	5	1.464		S.	I.	
4011	" "	8.7	" D . . .	5	2.796		S.	I.	
4012	" "	8.8	" C . . .	5	2.662		S.	I.	
4013	" "	9.0	" C . . .	5	2.206		U.	I.	
4014	" "	9.1	" D . . .	5	2.616		U.	I.	
4015	" "	9.2	" E . . .	5	1.442		U.	I.	
4016	" "	9.4	Iapetus . . .	5	2.010		P.	I.	
4017	" "	9.5	" . . .	5	2.236		U.	I.	
4018	" "	10.1	Sat. of Nept., α Ar. . .	5	.668		P.	I.	} Achromatic eye-piece, power 400.
4019	" "	10.3	" " . . .	5	.682		U.	I.	
4020	" "	8.6	11, 12 Camelopard. . .	4	31.22	153.57	P.	(II.)	135°, 10".
Total Number . . .				20059					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4021	Sept. 23	8.7	11, 12 Camelopard.	4	30.75	241.70	P.	(H.)	340°, 10".
4022	" "	9.2	" "	4	33.95	151.35	S.	(H.)	340°, 6".
4023	" "	9.4	" "	4	31.70	153.00	S.	(H.)	150°, 8".
4024	" "	9.7	β Capricorni . . .	4	19.92	235.88	S.	(H.)	270°, 15".
4025	" "	9.8	" "	4	18.63	147.37	S.	(H.)	270°, 15".
4026	" "	10.4	η Lyræ	4	11.60	241.90	P.	(H.)	300°, 3".
4027	" "	10.5	" "	4	8.25	151.75	P.	(H.)	110°, 5".
4028	Sept. 25	6.9	ε Cygni B	5	1.690		U.	I.	Sept. 25. Seeing 8, 6.
4029	" "	6.9	" C	5	.890		U.	I.	
4030	" "	7.0	" C	5	.936		S.	I.	
4031	" "	7.1	" B	5	2.010		S.	I.	
4032	" "	7.8	α Delphini D	5	4.298		U.	I.	
4033	" "	8.0	" E	5	1.446		U.	I.	
4034	" "	8.1	" D	5	4.212		P.	I.	
4035	" "	8.1	" E	5	1.786		P.	I.	
4036	" "	8.2	" C	5	1.796		P.	I.	
4037	" "	8.3	" C	5	1.874		U.	I.	
4038	" "	8.6	β Lyræ	4	12.05	235.90	S.	H.	180°, 4". } A out of field.
4039	" "	8.6	"	4	13.53	145.07	S.	H.	10°, 4". }
4040	" "	9.3	β Capricorni c	5	1.550		P.	I.	
4041	" "	9.4	" c	5	1.378		S.	I.	
4042	" "	9.8	Mimas	5	.828		P.	I.	
4043	" "	10.1	"	5	.718		U.	I.	
4044	" "	10.3	Iapetus	5	1.040		S.	I.	
4045	" "	10.5	"	5	.842		P.	I.	Reflected image visible at .37.
4046	" "	10.6	"	5	.874		U.	I.	
4047	" "	9.0	11, 12 Camelopard.	4	29.73	149.12	U.	(H.)	135°, 5".
4048	" "	9.1	" "	4	36.35	236.85	U.	(H.)	0°, 5".
4049	" "	9.3	ε , 5 Lyræ	4	47.75	144.75	U.	(H.)	270°, 7".
4050	" "	9.4	"	4	46.05	151.90	U.	(H.)	90°, 6".
4051	Sept. 27	6.5	α Ursæ Minoris	5	1.738		P.	I.	Aperture 12.7 cms.
4052	" "	7.1	μ Sagittarii D	5	3.694		U.	I.	A partly in field.
4053	" "	7.2	" D	5	4.144		P.	I.	Sept. 27. Seeing 7, 5, 4.
4054	" "	8.0	ξ Pegasi B	5	3.550		U.	I.	
4055	" "	8.2	" B	5	3.430		S.	I.	
4056	" "	8.6	α Arietis	5	1.440		S.	I.	
4057	" "	8.7	"	5	1.580		U.	I.	
4058	" "	8.9	Iapetus	5	.904		U.	I.	Image much blurred.
4059	" "	9.0	"	5	.770		P.	I.	
4060	" "	9.3	α Aurigæ	5	1.098		P.	I.	
4061	" "	9.4	"	5	1.010		U.	I.	[ful. Reject.
4062	" "	8.1	ε , 5 Lyræ	4	38.78	146.62	P.	(H.)	240°, 20". Record doubt-
4063	" "	8.2	"	4	36.90	148.80	P.	(H.)	30°, 10". $\epsilon < 5$ by esti-
4064	" "	8.3	"	4	42.02	148.13	P.	(H.)	240°, 5". [mate.
4065	" "	8.4	β Cygni	4	20.00	150.20	P.	(H.)	120°, 5".
4066	" "	8.4	"	4	21.90	241.45	P.	(H.)	300°, 5".
4067	" "	8.8	"	4	19.60	241.15	S.	(H.)	300°, 5". } Without driv-
4068	" "	9.0	"	4	17.60	151.70	S.	(H.)	100°, 5". } ing-clock.
4069	" "	9.2	ε , 5 Lyræ	4	46.57	146.52	S.	(H.)	210°, 5". } Without driv-
4070	" "	9.4	"	4	46.77	149.87	S.	(H.)	30°, 5". } ing-clock. 5
4071	" "	9.7	η Lyræ	4	8.27	149.83	U.	(H.)	300°, 5". } Lyræ much
4072	" "	9.8	"	4	9.43	240.62	U.	(H.)	90°, 5". } elongated.
4073	" "	9.9	11, 12 Camelopard.	4	38.50	148.00	U.	(H.)	330°, 6".
4074	" "	10.0	" "	4	34.15	235.80	U.	(H.)	170°, 7".
4075	Sept. 28	6.6	21 Sagittarii	4	27.85	236.65	P.	H.	225°, 3". } B well seen both
4076	" "	6.6	"	4	16.50	149.45	P.	H.	350°, 3". } sets, difference
4077	" "	6.9	"	4	14.57	238.97	S.	H.	250°, 3". } unaccountable
4078	" "	6.9	"	4	14.47	151.02	S.	H.	350°, 3". } Images could
4079	" "	7.1	"	4	23.48	237.88	P.	H.	225°, 3". } not be brought
4080	" "	9.1	Iapetus	5	.886		P.	I.	close enough.
Total Number				20328					Sept. 28. Seeing 7, 8, 8.

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4081	Sept. 28	9.2	Iapetus	5	.740		S.	I.	
4082	" "	9.3	α Aurigæ	5	1.288		P.	I.	
4083	" "	9.4	"	5	.960		S.	I.	
4084	" "	9.6	ϵ Pegasi D	5	1.692		P.	I.	
4085	" "	9.7	" D	5	1.396		S.	I.	
4086	" "	10.1	α Cygni c	5	.686		P.	I.	
4087	" "	10.3	ϵ Cygni c	5	.942		P.	I.	
4088	" "	8.7	ϵ , 5 Lyræ	4	52.40	237.90	S.	(H.)	210°, 5".
4089	" "	8.8	"	4	50.57	139.83	S.	(H.)	5 Lyræ decidedly $> \epsilon$
4090	" "	9.0	β Cygni	4	21.85	147.95	S.	(H.)	90°, 5". [by estimate.
4091	" "	9.1	"	4	21.70	238.65	S.	(H.)	280°, 5".
4092	" "	9.8	η Lyræ	4	8.20	238.20	P.	(H.)	100°, 5".
4093	" "	9.9	"	4	9.10	149.30	P.	(H.)	300°, 5".
4094	Sept. 29	6.5	Jupiter II	2	42.00	53.80	P.	H.	Image of satellite placed on image of its shadow and brought to equality with disk around it. Some clouds. Shadow near limb in last set.
4095	" "	6.7	" II	4	41.75	143.55	P.	H.	
4096	" "	6.8	" II	3	42.65	52.15	S.	H.	
4097	" "	7.1	" II	4	42.50	152.65	P.	H.	
4098	" "	7.8	21 Sagittarii	4	19.30	150.20	P.	H.	225°, 3". Sept. 29. See-
4099	" "	8.0	"	4	15.13	149.92	P.	H.	340°, 2". [ing 5, 7, 6.
4100	" "	8.7	Iapetus	5	.900		P.	I.	{ Faint star suspected 5s pr. Iapetus.
4101	" "	8.9	"	5	.800		S.	I.	
4102	" "	9.1	α Ursæ Minoris	4	2.87	150.22	S.	H.	60°, 5".
4103	" "	9.3	" "	4	.72	237.03	S.	H.	190°, 45". Imgs. of A, 60"
4104	" "	9.4	" "	4	2.22	238.02	S.	H.	250°, 20". " 40"
4105	" "	9.5	" "	4	2.92	238.57	S.	H.	270°, 5". " 18"
4106	" "	9.6	" "	4	3.70	238.95	S.	H.	350°, 8". " 10"
4107	" "	9.7	" "	4	4.80	239.85	S.	H.	350°, 13". " 5"
4108	" "	9.9	" "	4	9.07	240.27	S.	H.	190°, 15". " 3".
4109	" "	9.9	" "	4	1.80	236.20	S.	H.	190°, 50". A out of field.
4110	" "	10.1	α Aurigæ	5	1.420		P.	I.	
4111	" "	10.2	"	5	1.242		S.	I.	[length about 65.
4112	Sept. 30	6.4	γ Andromedæ	4	13.77	130.03	P.	O.	Red images, wave-
4113	" "	6.4	"	4	12.75	128.65	P.	O.	Yellow " " 60.
4114	" "	6.5	"	4	19.83	131.19	P.	O.	Green " " 55.
4115	" "	6.5	"	4	17.97	131.12	P.	O.	Blue " " 50.
4116	" "	6.5	"	4	19.25	130.50	P.	O.	Indigo " " 45.
4117	" "	7.5	ϵ Cygni c	5	1.232		P.	I.	Sept. 30. Seeing 5, 6, 7.
4118	" "	8.1	Iapetus	5	.886		P.	I.	
4119	" "	8.2	"	5	.792		S.	I.	
4120	" "	8.6	Hyperion	5	.280		S.	I.	
4121	" "	8.7	"	5	.298		P.	I.	
4122	" "	10.5	α Cygni c	5	.480		S.	I.	
4123	" "	10.5	" c	5	.508		P.	I.	
4124	" "	4.2	Sky	5	3.490		P.	(I.)	Effect of object-glass. Dome darkened for first two sets, light for next two. Object-glass out in last two. Clouds passing, halves of field varying in tint.
4125	" "	4.3	"	5	4.086		S.	(I.)	
4126	" "	4.4	"	5	3.230		P.	(I.)	
4127	" "	4.6	"	5	3.432		S.	(I.)	
4128	" "	4.7	"	5	3.932		P.	(I.)	
4129	" "	4.8	"	5	3.800		S.	(I.)	
4130	" "	10.1	η Lyræ	4	7.25	236.00	S.	(H.)	{ B seen with some dif- ficulty.
4131	" "	10.3	"	4	4.72	146.07	S.	(H.)	
4132	" "	22.5	Sky	5	1.630		S.	(I.)	Effect of object-glass. Dome darkened for first two sets, light for next two. Object-glass out in last two. Sky unformly blue, but halves of field differ in tint.
4133	" "	22.8	"	5	1.606		P.	(I.)	
4134	" "	22.9	"	5	1.722		S.	(I.)	
4135	" "	22.9	"	5	1.604		P.	(I.)	
4136	" "	23.0	"	5	2.092		S.	(I.)	
4137	" "	23.0	"	5	1.842		P.	(I.)	
4138	Oct. 1	9.3	Iapetus	5	.692		S.	I.	Oct. 1. Seeing 6, 6, 7.
4139	" "	9.3	"	5	.820		P.	I.	
4140	" "	9.5	Hyperion	5	.344		P.	I.	
Total Number . .				20598					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4141	Oct. 1	9.5	Hyperion	5	.282		S.	I.	
4142	" "	10.5	α Cygni c	5	.602		S.	I.	
4143	" "	10.1	η Lyræ	4	4.97	146.83	S.	(H.)	90°, 5". } B seen more easily than on Sept. 30.
4144	" "	10.3	"	4	6.40	236.35	S.	(H.)	
4145	Oct. 2	8.5	Star a	5	2.188		S.	I.	Two stars near stationary point of Saturn; a is about the ninth magnitude, b the eleventh. b precedes a . Both are compared with Saturn.
4146	" "	8.6	" b	5	.666		S.	I.	
4147	" "	8.6	" b	5	.602		P.	I.	
4148	" "	8.6	" a	5	2.818		P.	I.	
4149	" "	8.8	Iapetus	5	.862		P.	I.	Oct. 2. Seeing 5, 7, 5.
4150	" "	8.8	"	5	.742		S.	I.	
4151	Oct. 3	6.2	Jupiter I	14			S.	I.	Reappearance of Jupiter I. Seeing bad.
4152	" "	6.3	" I	5	2.066		S.	I.	
4153	" "	6.3	" I	5	2.302		S.	I.	Oct. 3. Seeing 7, 5, 5.
4154	" "	6.7	Star, Jupiter . . .	5	1.040		P.	I.	{ Star 8s.4 following Jupiter.
4155	" "	6.8	" "	5	.852		S.	I.	
4156	" "	7.0	Jupiter, R 3 . . .	5	1.720		P.	I.	{ For constant. Image of Jupiter large.
4157	" "	7.0	" R 3	5	1.966		S.	I.	
4158	" "	6.1	Jupiter II	8	22.13	60.30	P.	(H.)	Limit of visibility.
4159	" "	6.2	" I, II	14			P.	(H.)	Reappearance of Jupiter I.
4160	" "	6.3	" I, II	4	42.57	56.32	P.	(H.)	
4161	" "	6.3	" I, II	4	44.85	59.15	P.	(H.)	[tation.
4162	Oct. 4	6.3	Jupiter IV, I . . .	5	33.61	236.11	S.	H.	Jupiter IV. near occult.
4163	" "	6.3	" IV, I	4	29.90	237.40	S.	H.	Oct. 4. Seeing 5, 4, 3.
4164	" "	6.3	" IV, I	4	30.65	235.85	S.	H.	
4165	" "	6.4	" IV, I	2	24.75		S.	H.	
4166	" "	6.7	Jupiter, R 3 . . .	5	1.994		S.	I.	{ For constant.
4167	" "	6.8	" R 3	5	1.836		P.	I.	
4168	" "	9.8	Iapetus	5	.838		S.	I.	
4169	" "	9.9	"	5	.796		P.	I.	[for b .
4170	" "	10.0	Star	5	.614		P.	I.	Observed by mistake
4171	" "	10.1	" b	5	.634		P.	I.	{ See remark Oct. 2.
4172	" "	10.1	" b	5	.576		S.	I.	
4173	Oct. 5	5.7	Jupiter IV, II . . .	4	32.32	149.87	P.	H.	150°, 10".
4174	" "	5.7	" IV, II	4	37.57	149.37	P.	H.	320°, 10".
4175	" "	6.1	" IV, II	4	35.53	148.52	P.	H.	320°, 5".
4176	" "	6.1	" IV, II	4	34.78	149.28	P.	H.	150°, 5".
4177	" "	6.3	" IV, I	4	32.12	148.17	P.	H.	160°, 5".
4178	" "	6.3	" IV, I	4	34.78	149.50	P.	H.	300°, 5".
4179	" "	8.1	" IV, II	4	32.95	150.00	P.	H.	220°, 5". Passing clouds.
4180	" "	8.2	" IV, II	4	32.95	150.25	P.	H.	100°, 5".
4181	" "	8.8	" IV, II	4	33.45	147.10	S.	H.	180°, 5".
4182	" "	8.9	" IV, II	4	35.08	240.07	S.	H.	45°, 5". [satellite.
4183	Oct. 6	6.3	Star, Jupiter III . .	4	12.95	148.50	P.	H.	350°, 10". Faint star nr.
4184	" "	6.4	" " III	4	11.78	238.62	P.	H.	190°, 10". Oct. 6. See-
4185	" "	6.5	" " III	4	13.17	237.73	S.	H.	190°, 10". [ing 5, 5, 5.
4186	" "	6.5	" " III	4	13.47	148.07	S.	H.	350°, 10".
4187	" "	7.2	Iapetus	3	.610		S.	I.	Interrupted by clouds.
4188	" "	7.8	"	5	.730		P.	I.	
4189	" "	8.0	Star b	5	.628		P.	I.	{ See remark Oct. 2.
4190	" "	8.0	" a	5	2.274		P.	I.	
4191	" "	8.3	Iapetus	5	.674		S.	I.	
4192	" "	8.5	Star a	5	1.788		S.	I.	{ See remark Oct. 2.
4193	" "	8.6	" b	5	.590		S.	I.	
4194	" "	8.9	γ Andromedæ . . .	4	13.50	219.05	P.	O.	Red images.
4195	" "	8.9	"	4	15.25	219.75	P.	O.	Yellow "
4196	" "	9.0	"	4	15.65	219.75	P.	O.	Green "
4197	" "	9.0	"	4	16.65	217.70	P.	O.	Blue "
4198	" "	9.2	"	4	20.33	220.17	P.	O.	Indigo "
4199	" "	9.3	"	4	13.45	219.60	S.	O.	Red "
4200	" "	9.4	"	4	13.80	220.45	S.	O.	Yellow "
Total Number . .				20887					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4201	Oct. 6	9.5	γ Andromedæ . .	4	14.25	219.90	S.	O.	Green images.
4202	" "	9.6	" " . .	4	15.20	220.35	S.	O.	Blue "
4203	" "	9.8	β Cygni	4	18.13	130.07	P.	O.	Red "
4204	" "	9.9	" "	4	19.62	131.23	S.	O.	" "
4205	" "	9.9	" "	4	21.52	131.23	P.	O.	Yellow "
4206	" "	10.0	" "	4	21.38	130.32	S.	O.	" " Color too [red.]
4207	" "	10.1	" "	4	25.85	128.70	P.	O.	Green "
4208	" "	10.1	" "	4	22.37	129.98	S.	O.	" "
4209	" "	10.2	" "	4	30.45	129.95	P.	O.	Blue "
4210	" "	10.2	" "	4	34.10	216.00	S.	O.	" "
4211	" "	10.3	" "	4	36.72	129.73	P.	O.	Indigo "
4212	" "	10.3	" "	4	36.00	216.20	S.	O.	" "
4213	Oct. 8	6.6	Jupiter I, III . .	4	40.75	149.55	S.	H.	} 90°, 6". In line. Jupiter out of field. Oct. 8. Seeing 3, 8, 8.
4214	" "	6.7	" I, III	4	43.00	150.05	S.	H.	
4215	" "	6.8	" I, III	4	41.35	236.30	U.	H.	
4216	" "	6.8	" I, III	4	39.67	149.32	U.	H.	
4217	Oct. 10	7.4	Jupiter, R 3 . . .	5	1.580		S.	I.	} For const. Reflected image small.
4218	" "	7.5	" R 3	5	1.454		U.	I.	
4219	" "	7.7	" R 3	5	1.314		P.	I.	
4220	" "	8.0	Jupiter	5	.304		P.	I.	Limit of visibility.
4221	" "	8.1	" I	10			P.	I.	} Reappearance of Jupiter I.
4222	" "	8.1	" I	5	2.178		P.	I.	
4223	" "	8.1	" I	5	2.558		P.	I.	} Comparisons difficult, owing to size of satellite.
4224	" "	8.2	" I	5	2.678		P.	I.	
4225	" "	8.2	" I	5	3.572		P.	I.	
4226	" "	8.2	" I	5	3.730		P.	I.	
4227	" "	8.5	Iapetus	5	.854		P.	I.	Oct. 10. Seeing 5, 6, 5.
4228	" "	8.6	Star <i>b</i>	5	.646		P.	I.	} See remark, Oct. 2.
4229	" "	8.7	" <i>b</i>	5	.568		U.	I.	
4230	" "	8.8	Iapetus	5	1.224		U.	I.	} See remark, Oct. 2.
4231	" "	9.8	"	5	.938		S.	I.	
4232	" "	10.0	Star <i>b</i>	5	.440		S.	I.	See remark, Oct. 2.
4233	" "	8.1	Jupiter I, III . .	10			S.	(H.)	} Reappearance of Jupiter I.
4234	" "	8.2	" I, III	4	33.22	148.33	S.	(H.)	
4235	Oct. 13	5.9	Jupiter I, III . .	4	39.80	144.25	P.	H.	} 90°, 5". Oct. 13. Seeing 4, 6, 4.
4236	" "	5.9	" I, III	4	39.63	143.32	P.	H.	
4237	" "	6.0	" I, III	4	41.17	145.18	S.	H.	} 90°, 6".
4238	" "	6.0	" I, III	4	40.85	143.80	S.	H.	
4239	" "	6.1	" IV, I	4	36.67	145.33	S.	H.	340°, 6".
4240	" "	6.2	" IV, I	4	33.30	235.90	S.	H.	150°, 6".
4241	" "	6.2	" IV, I	4	32.65	235.25	P.	H.	140°, 6".
4242	" "	6.2	" IV, I	4	35.65	144.85	P.	H.	350°, 6".
4243	" "	6.4	Jupiter, R 3 . . .	5	1.816		P.	I.	} For constant.
4244	" "	6.4	" R 3	5	1.510		S.	I.	
4245	" "	6.8	Iapetus	5	1.230		P.	I.	} See remark, Oct. 2.
4246	" "	6.8	Star <i>b</i>	5	.598		S.	I.	
4247	" "	7.0	" <i>a</i>	5	1.780		S.	I.	} See remark, Oct. 2.
4248	" "	7.6	Iapetus	6	1.240		S.	I.	
4249	" "	7.7	Star <i>b</i>	5	.704		P.	I.	} See remark, Oct. 2.
4250	" "	7.8	" <i>a</i>	5	2.868		P.	I.	
4251	Oct. 14	6.2	Jupiter IV, III . .	4	32.80	144.50	P.	H.	} 330°, 5". Oct. 14. Seeing 5, 6, 6.
4252	" "	6.3	" IV, III	4	32.00	233.45	P.	H.	
4253	" "	6.9	Iapetus	5	1.168		U.	I.	} See remark, Oct. 2.
4254	" "	7.0	Star <i>b</i>	5	.804		U.	I.	
4255	" "	7.2	Jupiter IV, III . .	4	34.83	144.57	U.	H.	90°, 8".
4256	" "	7.3	" IV, III	4	30.80	234.70	U.	H.	310°, 9".
4257	" "	7.5	Jupiter, R 3 . . .	5	1.300		U.	I.	} For constant.
4258	" "	7.5	" R 3	5	1.526		P.	I.	
4259	" "	7.7	Iapetus	5	1.338		P.	I.	} See remark, Oct. 2.
4260	" "	7.8	Star <i>b</i>	5	.696		P.	I.	
Total Number . .				21169					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4261	Oct. 14	7.9	Mimas	2	.675		U.	I.	Two images not seen at once.
4262	" "	8.5	Iapetus	5	1.240		S.	I.	
4263	" "	8.6	Star <i>b</i>	5	.904		S.	I.	See remark, Oct. 2.
4264	" "	9.0	β Cygni	5	23.63	129.07	S.	O.	Red images.
4265	" "	9.1	"	5	23.05	130.45	S.	O.	Yellow "
4266	" "	9.2	"	5	25.67	130.63	S.	O.	Green "
4267	" "	9.2	"	5	36.93	133.28	S.	O.	Blue " Refocussed.
4268	" "	9.4	"	5	40.53	131.97	S.	O.	Indigo " Very faint.
4269	" "	9.6	"	5	20.65	128.90	U.	O.	Red "
4270	" "	9.7	"	5	22.77	130.78	U.	O.	Yellow "
4271	" "	9.8	"	5	26.65	130.45	U.	O.	Green "
4272	" "	9.8	"	5	32.83	131.12	U.	O.	Blue " Refocussed.
4273	" "	9.9	"	5	40.47	218.92	U.	O.	Indigo "
4274	" "	10.0	"	5	41.60	218.60	U.	O.	Violet "
4275	Oct. 15	6.5	Jupiter, R 3	5	1.438		S.	I.	For constant.
4276	" "	6.6	Jupiter	5	.644		S.	I.	Limit of visibility.
4277	" "	6.6	" II	10			S.	I.	Reap. of Jupiter II.
4278	" "	6.7	" II	5	3.014		S.	I.	Oct. 15. Seeing 6, 7, 5.
4279	" "	6.7	" II	5	2.892		S.	I.	
4280	" "	8.2	Jupiter, R 3	5	1.332		U.	I.	} For constant.
4281	" "	8.3	" R 3	5	1.264		P.	I.	
4282	" "	8.8	Iapetus	5	1.090		U.	I.	
4283	" "	8.9	"	5	1.582		S.	I.	
4284	" "	9.0	Star <i>a</i>	5	2.126		S.	I.	} See remark, Oct. 2.
4285	" "	9.0	" <i>b</i>	5	.990		S.	I.	
4286	" "	9.1	" <i>b</i>	5	.904		P.	I.	
4287	" "	9.1	Iapetus	5	1.512		P.	I.	
4288	" "	9.3	Star <i>b</i>	5	.730		U.	I.	See remark, Oct. 2.
4289	" "	9.7	γ Andromedæ	5	14.10	219.30	S.	O.	Red images.
4290	" "	9.7	"	5	14.17	219.47	S.	O.	Yellow "
4291	" "	9.7	"	5	16.55	219.35	S.	O.	Green "
4292	" "	9.7	"	5	19.77	219.17	S.	O.	Blue "
4293	" "	9.8	"	5	37.33	218.17	S.	O.	Indigo " Refocussed.
4294	" "	6.5	Jupiter I	4	23.17	324.73	P.	(H.)	Limit of visibility.
4295	" "	6.6	" II, I	11			P.	(H.)	Reappearance of Jupiter II.
4296	" "	6.7	" II, I	4	41.93	191.42	P.	(H.)	
4297	" "	6.8	" II, I	4	42.53	144.47	P.	(H.)	
4298	Oct. 16	6.7	Jupiter, R 3	5	1.760		S.	I.	} For constant.
4299	" "	6.8	" R 3	5	1.310		P.	I.	
4300	" "	6.9	" R 3	5	1.318		U.	I.	
4301	" "	7.2	Iapetus	5	1.702		U.	I.	
4302	" "	7.3	Star <i>b</i>	5	1.106		U.	I.	} See remark, Oct. 2.
4303	" "	7.5	" <i>a</i>	5	4.282		U.	I.	
4304	" "	7.6	" <i>a</i>	5	3.068		P.	I.	
4305	" "	7.6	" <i>b</i>	5	1.176		P.	I.	
4306	" "	7.7	Iapetus	5	1.432		P.	I.	Oct. 16. Seeing 7, 8, 7.
4307	" "	8.2	Jupiter III, I	36			P.	I.	Reappearance of Jupiter III.
4308	" "	8.3	" III, I	4	54.45	145.30	P.	I.	
4309	" "	8.3	" I	4	9.90	144.45	P.	I.	} Limit of visibility.
4310	" "	8.3	" III	4	7.70	54.70	P.	I.	
4311	" "	8.4	" III, I	4	55.48	145.12	P.	I.	
4312	" "	10.1	Sat. of Nept., α Ar.	5	1.208		P.	I.	Achromatic eye-piece, power 400.
4313	" "	8.8	Pallas, λ Aquarii	5	4.156		S.	(I.)	} 1st star preceding Pallas, 2d star following.
4314	" "	9.0	Star, "	5	3.404		S.	(I.)	
4315	" "	9.2	" "	5	2.876		S.	(I.)	
4316	Oct. 17	6.8	Jupiter, R 3	5	1.600		P.	I.	} For constant.
4317	" "	6.9	" R 3	5	1.578		U.	I.	
4318	" "	6.9	" R 3	5	1.876		S.	I.	
4319	" "	7.3	Iapetus	5	2.386		S.	I.	Oct. 17. Seeing 7, 5, 5.
4320	" "	7.4	"	5	1.336		U.	I.	Haze.
Total Number				21501					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4321	Oct. 17	7.5	Star <i>b</i>	5	.912		U.	I.	{ See remark, Oct. 2.
4322	" "	7.5	" <i>b</i>	5	1.006		P.	I.	
4323	" "	7.6	Iapetus	5	1.996		P.	I.	Red images. Yellow " Green " Blue " Indigo " Violet " Red " Yellow " Out of focus. Green " Refocussed. Blue " Violet " Refocussed. Indigo " "
4324	" "	8.0	β Cygni	4	17.38	219.77	P.	O.	
4325	" "	8.0	"	4	19.00	218.95	P.	O.	
4326	" "	8.0	"	4	25.00	220.10	P.	O.	
4327	" "	8.1	"	4	31.58	219.98	P.	O.	
4328	" "	8.2	"	4	30.72	220.82	P.	O.	
4329	" "	8.2	"	4	38.10	221.45	P.	O.	
4330	" "	8.9	γ Andromedæ	4	13.57	128.92	U.	O.	
4331	" "	8.9	"	4	11.33	130.33	U.	O.	
4332	" "	8.9	"	4	14.38	129.23	U.	O.	
4333	" "	9.0	"	4	14.38	130.17	U.	O.	130°, 30". In line. A out [of field. } 130°, 30". Reappearance of Jupiter I. S. I. S. I. S. (I.) S. (I.) S. (I.) P. (H.) Limit of visibility. P. (H.) Reappearance of Jupiter I. P. (H.) U. I. For constant. S. H. 180°, 5". S. H. 10°, 5". P. H. 30°, 8". Clouds. S. I. For constant. P. H. 120°, 5". Oct. 20. See- P. H. 250°, 5". [ing 4, 6, 4. S. H. 260°, 5". S. H. 110°, 5". P. H. { 100°, 5". Symmetrical- H. ly placed as regards IV. S. H. { 200°, 7". Symmetrical S. H. } with regard to III. S. I. By mistake, for Iapetus. S. I. Hazy. S. I. { See remark, Oct. 2. P. I. { S. H. } 120°, 30". P. H. { U. H. 120°, 30". U. I. For constant. S. I. Oct. 21. Seeing 8, 7, 7. S. I. { See remark, Oct. 2. U. I. { U. I. { U. I. { P. I. [400. P. I. Ach. eye-piece, power P. I. Ach. eye-piece. Saturn visible at .22.
4334	" "	9.0	"	4	27.30	127.85	U.	O.	
4335	" "	9.1	"	4	22.33	130.68	U.	O.	
4336	" "	9.2	α Ceti	4	2.95	142.45	P.	H.	
4337	" "	9.3	"	4	2.57	232.73	P.	H.	
4338	" "	9.3	"	4	3.15	233.00	U.	H.	
4339	" "	9.3	"	4	3.07	142.57	U.	H.	
4340	" "	10.0	Jupiter I	9			S.	I.	
4341	" "	10.0	" I	5	3.290		S.	I.	
4342	" "	10.1	" I	5	3.124		S.	I.	
4343	" "	8.7	" III	5	1.328		S.	(I.)	
4344	" "	9.3	" II	5	1.590		S.	(I.)	
4345	" "	9.3	" IV	5	.982		S.	(I.)	
4346	" "	9.9	" III	4	22.40	59.45	P.	(H.)	
4347	" "	10.0	" I, III	8			P.	(H.)	
4348	" "	10.1	" I, III	4	34.45	62.55	P.	(H.)	
4349	" "	10.1	" I, III	4	36.30	60.00	P.	(H.)	
4350	Oct. 18	6.7	Jupiter, R 3	5	1.730		U.	I.	For constant. 180°, 5". 10°, 5". 30°, 8". Clouds. For constant. 120°, 5". Oct. 20. See- 250°, 5". [ing 4, 6, 4. 260°, 5". 110°, 5". 100°, 5". Symmetrical- ly placed as regards IV. 200°, 7". Symmetrical with regard to III. By mistake, for Iapetus. Hazy. See remark, Oct. 2. 120°, 30". 120°, 30". For constant. Oct. 21. Seeing 8, 7, 7. See remark, Oct. 2. [400. Ach. eye-piece, power Ach. eye-piece. Saturn visible at .22.
4351	Oct. 19	5.7	Jupiter II, III	4	40.85	148.40	S.	H.	
4352	" "	5.8	" II, III	4	42.67	146.97	S.	H.	
4353	" "	5.8	" II, III	2	39.75	61.25	P.	H.	
4354	Oct. 20	6.2	Jupiter, R 3	5	1.688		S.	I.	
4355	" "	6.4	Jupiter IV, III	4	27.55	148.00	P.	H.	
4356	" "	6.5	" IV, III	4	30.55	238.45	P.	H.	
4357	" "	6.5	" IV, III	4	31.30	236.15	S.	H.	
4358	" "	6.5	" IV, III	4	29.87	147.88	S.	H.	
4359	" "	6.6	" I, III	4	38.67	237.18	P.	H.	
4360	" "	6.7	" I, III	4	41.22	147.98	P.	H.	
4361	" "	6.8	" IV, I	4	32.40	232.30	S.	H.	By mistake, for Iapetus. Hazy. See remark, Oct. 2. 120°, 30". 120°, 30". For constant. Oct. 21. Seeing 8, 7, 7. See remark, Oct. 2. [400. Ach. eye-piece, power Ach. eye-piece. Saturn visible at .22.
4362	" "	6.9	" IV, I	4	38.30	143.80	S.	H.	
4363	" "	8.1	Star	5	.844		S.	I.	
4364	" "	8.3	Iapetus	5	1.828		S.	I.	
4365	" "	8.4	"	5	1.778		P.	I.	
4366	" "	8.6	Star <i>a</i>	5	2.628		S.	I.	
4367	" "	8.6	" <i>a</i>	5	3.078		P.	I.	
4368	" "	9.7	α Ceti	4	2.85	233.30	S.	H.	
4369	" "	9.8	"	4	2.20	143.15	S.	H.	
4370	" "	9.9	"	4	2.52	143.03	P.	H.	
4371	" "	10.0	"	4	2.98	232.52	P.	H.	[400. Ach. eye-piece, power Ach. eye-piece. Saturn visible at .22.
4372	Oct. 21	6.7	Jupiter, R 3	5	1.498		U.	I.	
4373	" "	7.0	Iapetus	5	2.018		S.	I.	
4374	" "	7.1	Star <i>a</i>	5	2.258		S.	I.	
4375	" "	7.3	" <i>a</i>	5	3.386		U.	I.	
4376	" "	7.3	Iapetus	5	1.478		U.	I.	
4377	" "	7.4	Hyperion	5	.466		U.	I.	
4378	" "	7.6	Mimas	5	.814		U.	I.	
4379	" "	8.0	"	5	.890		P.	I.	
4380	" "	8.3	Hyperion	5	.482		P.	I.	
Total Number				21772					

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No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4381	Oct. 21	8.3	Iapetus	5	1.932		P.	I.	
4382	" "	8.4	Star <i>a</i>	5	3.800		P.	I.	See remark, Oct. 2.
4383	" "	8.9	Hyperion	5	.394		S.	I.	
4384	" "	9.3	Jupiter I	5	1.478		P.	(I.)	
4385	" "	9.3	" IV	5	.872		P.	(I.)	
4386	" "	9.3	" IV	5	.710		S.	(I.)	
4387	" "	9.4	" I	5	1.040		S.	(I.)	
4388	" "	9.6	" III	5	1.528		S.	(I.)	
4389	" "	9.7	" II	5	.950		S.	(I.)	
4390	" "	9.8	" II	5	1.008		P.	(I.)	
4391	" "	9.9	" III	5	1.536		P.	(I.)	
4392	" "	10.0	Iapetus	5	.612		P.	(I.)	
4393	Oct. 22	6.1	Iapetus	5	1.686		P.	I.	Oct. 22. Seeing 4, 7, 7.
4394	" "	6.1	Star <i>a</i>	5	3.358		P.	I.	{ See remark Oct. 2.
4395	" "	6.2	" <i>a</i>	5	2.654		S.	I.	
4396	" "	6.3	Iapetus	5	1.744		S.	I.	
4397	" "	6.5	"	5	1.648		U.	I.	
4398	" "	6.6	Star <i>b</i>	5	1.008		U.	I.	See remark Oct. 2.
4399	" "	6.8	Jupiter, R 3	5	1.508		U.	I.	For constant.
4400	" "	8.7	o Ceti	4	1.92	141.83	S.	H.	135°, 30".
4401	" "	8.8	"	4	2.58	232.03	S.	H.	130°, 30".
4402	" "	9.2	Jupiter	5	1.242		P.	I.	Limit of visibility.
4403	" "	9.3	" II	12			P.	I.	Reap. of Jupiter II.
4404	" "	9.3	" II	5	3.148		P.	I.	Jupiter low, sky bright, and satellites faint.
4405	" "	9.4	" II	5	3.292		P.	I.	
4406	" "	9.4	" II	5	3.386		P.	I.	
4407	" "	9.6	Hyperion	5	.482		U.	I.	Achromatic eye-piece, power 400.
4408	" "	8.3	Jupiter I	5	1.264		U.	(I.)	
4409	" "	8.3	" III	5	1.476		U.	(I.)	
4410	" "	8.4	" IV	5	1.074		U.	(I.)	
4411	" "	8.7	" IV	5	.898		P.	(I.)	
4412	" "	8.9	" I	5	1.632		P.	(I.)	
4413	" "	9.0	" III	5	2.010		P.	(I.)	
4414	Oct. 24	7.5	" II	6	1.603		P.	(I.)	
4415	" "	7.6	" II	5	1.170		U.	(I.)	
4416	Oct. 26	6.4	Jupiter III	4	13.32	140.38	S.	H.	Limit of visibility.
4417	" "	6.4	" I, III	22			S.	H.	Reap. of Jupiter I.
4418	" "	6.5	" I, III	4	39.68	142.78	S.	H.	Oct. 26. Seeing 9, 7, 8.
4419	" "	6.5	" I, III	4	42.95	143.90	S.	H.	
4420	" "	7.4	Iapetus	5	1.524		P.	I.	[unusually bright.
4421	" "	7.5	Star <i>b</i>	5	1.162		P.	I.	See rem., Oct. 2. <i>b</i> looks
4422	" "	8.4	Sat. of Nept., α Ar.	5	.638		P.	I.	Achr. eye-piece, power 400.
4423	" "	8.8	" " " " " "	5	.614		S.	I.	Limit of visibility .50.
4424	" "	6.4	Jupiter I	12			P.	(I.)	Reap. of Jupiter I.
4425	" "	6.5	" I	5	1.554		P.	(I.)	
4426	" "	6.5	" I	5	1.848		P.	(I.)	
4427	" "	6.5	"	5	.372		P.	(I.)	Limit of visibility.
4428	" "	7.2	" I	5	1.728		S.	(I.)	
4429	Oct. 28	9.6	Sat. of Nept., α Ar.	5	.586		P.	I.	{ Achr. eye-piece, power 400. Limit of visibility, .38 (P.), .47 (S.), .39 (U.).
4430	" "	9.8	" " " " " "	5	.532		S.	I.	
4431	" "	10.0	" " " " " "	5	.512		U.	I.	Oct. 28. Seeing 7, 4, 5.
4432	" "	10.6	Iapetus	5	1.430		P.	I.	See remark Oct. 2.
4433	" "	10.7	Star <i>b</i>	5	.836		P.	I.	
4434	" "	10.8	Hyperion	6	.505		P.	I.	
4435	" "	9.0	Neptune, α Arietis	5	3.488		P.	(I.)	
4436	" "	9.3	" " " " " "	5	3.060		S.	(I.)	
4437	Oct. 29	7.8	Star <i>b</i>	5	.926		U.	I.	See remark Oct. 2.
4438	" "	8.1	Iapetus	5	1.638		U.	I.	Oct. 29. Seeing 6, 7, 7.
4439	" "	8.1	"	5	1.726		P.	I.	
4440	" "	8.2	Star <i>b</i>	5	.924		P.	I.	See remark Oct. 2.
Total Number . .				22100					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4441	Oct. 29	8.2	Hyperion	5	.466		P.	I.	
4442	" "	8.6	Sat. of Nept., α Ar.	5	.770		P.	I.	
4443	" "	8.8	" "	5	.622		U.	I.	
4444	" "	9.6	Iapetus	5	1.748		S.	I.	[Oct. 2.
4445	" "	9.7	Star a	5	5.108		S.	I.	Very hazy. See remark
4446	Nov. 1	6.5	Hyperion	5	.322		P.	I.	Unusually faint.
4447	" "	6.7	"	5	.304		U.	I.	Delayed by cloud.
4448	" "	7.0	"	5	.250		S.	I.	Limit of visibility .21.
4449	" "	7.1	Iapetus	5	1.228		S.	I.	Nov. 1. Seeing 6, 4, 4.
4450	" "	7.2	Star b	5	.824		S.	I.	{ See remark Oct. 2.
4451	" "	7.2	" b	5	.728		P.	I.	
4452	" "	7.2	Iapetus	5	1.248		P.	I.	
4453	" "	7.3	"	5	1.400		U.	I.	
4454	" "	7.5	Star b	5	.730		U.	I.	b small and sharp. See
4455	Nov. 2	7.7	Iapetus	5	1.464		P.	I.	remark Oct. 2.
4456	" "	7.8	Star b	5	.836		P.	I.	{ See remark Oct. 2.
4457	" "	7.8	" a	5	2.902		P.	I.	
4458	" "	8.0	Hyperion	5	.358		P.	I.	Limit of visibility .35.
4459	" "	8.3	Jupiter	4	12.22	144.08	P.	H.	Limit of visibility.
4460	" "	8.3	" I, III	14			P.	H.	Reap. of Jupiter I.
4461	" "	8.4	" I, III	4	37.47	142.73	P.	H.	
4462	" "	8.4	" I, III	4	38.30	142.05	P.	H.	
4463	" "	8.3	"	5	.426		S.	(I.)	Limit of visibility.
4464	" "	8.3	" I	14			S.	(I.)	Reap. of Jupiter I.
4465	" "	8.4	" I	5	1.248		S.	(I.)	
4466	" "	8.4	" I	5	1.366		S.	(I.)	
4467	Nov. 3	6.0	Iapetus	5	1.390		P.	I.	
4468	" "	6.0	Star b	5	.664		P.	I.	{ See remark Oct. 2.
4469	" "	6.1	" b	5	.708		S.	I.	
4470	" "	6.2	Iapetus	5	.786		S.	I.	Another setting by P.
4471	Nov. 4	7.8	Iapetus	5	1.310		P.	I.	gave 1.35.
4472	" "	7.9	Star b	5	.592		P.	I.	{ See remark Oct. 2.
4473	" "	7.9	" b	5	.658		U.	I.	
4474	" "	8.0	Iapetus	5	1.192		U.	I.	
4475	" "	9.5	"	5	1.178		S.	I.	
4476	" "	9.6	Star b	5	.676		S.	I.	See remark Oct. 2.
4477	" "	8.8	Neptune, α Arietis	5	3.152		P.	(I.)	
4478	" "	9.1	" "	5	3.750		S.	(I.)	
4479	" "	9.4	" "	5	4.026		U.	(I.)	
4480	Nov. 5	4.6	Jupiter II, I	4	40.35	147.35	P.	H.	Very difficult.
4481	" "	4.7	" II, I	4	43.10	144.20	P.	H.	Nov. 5. Seeing 3, 7, 8.
4482	" "	4.7	" II, I	4	40.45	144.90	P.	H.	10°, 10".
4483	" "	4.8	" II, I	4	41.15	143.75	P.	H.	0°, 10". Easy.
4484	" "	5.3	" II, I	4	43.73	142.38	P.	H.	0°, 20".
4485	" "	5.3	" II, I	4	42.77	145.52	P.	H.	180°, 10".
4486	" "	6.3	" II, I	4	46.60	143.05	S.	H.	150°, 5".
4487	" "	6.4	" II, I	4	49.33	142.83	S.	H.	330°, 5".
4488	" "	6.5	" IV, III	4	29.98	142.93	S.	H.	160°, 5". [cloudy.
4489	" "	6.6	" IV, III	4	30.27	232.93	S.	H.	320°, 5". Somewhat
4490	" "	9.4	Star b	5	3.542		P.	J.	{ See remark Oct. 2.
4491	" "	9.5	" b	5	3.216		U.	J.	
4492	" "	9.6	" b	5	3.352		S.	J.	{ Moon near. Clouds
4493	" "	6.4	Juno, δ Capricorni	5	3.184		P.	(I.)	
4494	" "	6.5	Star, "	5	3.698		P.	(I.)	{ Star, 8th magnitude, near
4495	" "	6.7	" "	5	3.978		U.	(I.)	
4496	" "	6.7	Juno, "	5	3.002		U.	(I.)	{ Juno, with faint com- panion pr.
4497	Nov. 6	5.3	Jupiter II, I	4	47.37	144.73	P.	H.	
4498	" "	5.3	" II, I	4	44.88	144.73	P.	H.	270°, 5".
4499	" "	8.2	" II, I	4	41.97	143.52	U.	H.	50°, 4".
4500	" "	8.3	" II, I	4	43.80	143.20	U.	H.	50°, 4".
Total Number . .				22401					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4501	Nov. 6	9.8	Sat. of Nept., α Ar.	5	.560		P.	I.	Achr. eye-piece, power 400. Neptune out of field. Satel. well seen.
4502	" "	10.0	" "	5	.584		S.	I.	
4503	" "	10.1	" "	5	.578		U.	I.	
4504	" "	8.5	Juno, δ Capricorni	5	2.264		P.	(I.)	Not quite full aperture.
4505	" "	8.5	Star, "	5	3.359		P.	(I.)	See remark, Nov. 5.
4506	" "	8.7	" "	5	4.378		S.	(I.)	{ Another star, also with faint companion preced'g. By mistake for Juno.
4507	" "	8.9	" "	5	1.712		S.	(I.)	
4508	" "	9.0	Juno, "	5	2.684		S.	(I.)	
4509	" "	9.1	Star, "	5	3.862		S.	(I.)	See remark, Nov. 5.
4510	" "	9.3	" "	5	3.118		U.	(I.)	
4511	" "	9.4	Juno, "	5	3.022		U.	(I.)	
4512	Nov. 7	6.2	Jupiter IV, III . .	4	24.95	230.55	S.	H.	250°, 25". Nov. 7. Seeing 7, 8, 8.
4513	" "	6.4	" IV, III . .	4	25.12	230.57	S.	H.	
4514	" "	6.5	" IV, III . .	4	28.20	141.25	S.	H.	
4515	" "	6.5	" IV, III . .	4	28.03	139.97	S.	H.	
4516	" "	6.5	" IV, III . .	4	25.18	143.48	S.	H.	
4517	" "	6.6	" IV, III . .	30			S.	H.	Disappearance of Jupiter IV. Clouds.
4518	" "	9.3	Hyperion . . .	5	.578		P.	I.	
4519	" "	9.4	" . . .	2	.430		U.	I.	Clouds.
4520	" "	6.3	Jupiter IV . . .	5	1.032		P.	(I.)	
4521	" "	6.3	" IV . . .	5	1.260		P.	(I.)	
4522	" "	6.4	" IV . . .	5	1.066		P.	(I.)	
4523	" "	6.4	" IV . . .	5	1.062		P.	(I.)	
4524	" "	6.4	" IV . . .	5	1.104		P.	(I.)	
4525	" "	6.4	" IV . . .	5	1.166		P.	(I.)	
4526	" "	6.4	" IV . . .	5	1.294		P.	(I.)	
4527	" "	6.5	" IV . . .	5	1.124		P.	(I.)	
4528	" "	6.5	" IV . . .	5	1.222		P.	(I.)	
4529	" "	6.5	" IV . . .	5	1.228		P.	(I.)	[ter IV. Clouds.
4530	" "	6.6	" IV . . .	29			P.	(I.)	Disappearance of Jupiter IV. Clouds.
4531	" "	6.7	" IV . . .	5	.684		P.	(I.)	Limit of visibility.
4532	Nov. 8	6.5	Star b . . .	5	.788		S.	I.	See remark, Oct. 2.
4533	" "	6.6	Iapetus . . .	5	1.316		S.	I.	
4534	" "	6.8	" . . .	5	1.484		P.	I.	
4535	" "	6.8	Star b . . .	5	.942		P.	I.	{ See remark, Oct. 2.
4536	" "	7.3	" b . . .	5	.716		U.	I.	
4537	" "	7.4	Iapetus . . .	5	1.096		U.	I.	
4538	Nov. 10	5.8	Iapetus . . .	5	1.466		P.	I.	
4539	" "	5.9	Star b . . .	5	.972		P.	I.	{ See remark, Oct. 2.
4540	" "	6.0	" b . . .	5	.886		S.	I.	
4541	" "	6.0	Iapetus . . .	5	1.412		S.	I.	
4542	Nov. 12	6.8	Jupiter II, I . .	4	44.00	143.65	S.	H.	340°, 5".
4543	" "	6.8	" II, I . .	4	39.13	231.47	S.	H.	135°, 5".
4544	" "	7.2	Sat. of Nept., α Ar.	5	.624		P.	I.	Satellite very distinct.
4545	" "	7.3	" "	5	.612		U.	I.	
4546	" "	7.4	" "	5	.636		U.	I.	Plainly seen at intervals.
4547	" "	7.5	" "	5	.766		P.	I.	
4548	" "	7.7	Iapetus . . .	5	1.554		P.	I.	
4549	" "	7.7	Star b . . .	5	.936		P.	I.	{ See remark, Oct. 2.
4550	" "	7.8	" b . . .	5	.752		U.	I.	[ing 7, 8, 9.
4551	" "	7.8	Iapetus . . .	5	1.406		U.	I.	
4552	Nov. 13	6.2	Jupiter IV, II . .	4	36.42	144.43	S.	H.	60°, 90". Nov. 13. Seeing 7, 8, 9.
4553	" "	6.4	" IV, II . .	4	42.17	143.78	S.	H.	60°, 90".
4554	" "	6.5	" IV, II . .	4	41.95	137.90	U.	H.	45°, 90". [clouds.
4555	" "	6.6	" IV, II . .	4	42.03	238.52	U.	H.	45°, 90". Barely seen; See remark, Oct. 2.
4556	" "	6.8	Star b . . .	5	1.286		S.	I.	
4557	" "	6.9	Iapetus . . .	5	1.484		S.	I.	
4558	" "	7.1	Star b . . .	5	.924		U.	I.	See remark, Oct. 2.
4559	" "	7.2	Iapetus . . .	5	1.592		U.	I.	
4560	" "	9.9	Mimas . . .	5	.584		U.	I.	Unusually distinct.
Total Number . .				22736					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4561	Nov. 13	10.0	Enceladus . . .	5	.832		U.	I.	
4562	" "	10.1	Mimas . . .	5	.638		S.	I.	
4563	" "	10.2	Enceladus . . .	5	.778		S.	I.	
4564	" "	10.3	Mimas . . .	5	.602		P.	I.	} Alternate settings.
4565	" "	10.3	Enceladus . . .	5	.782		P.	I.	
4566	" "	10.5	Hyperion . . .	5	.448		P.	I.	
4567	" "	10.6	" . . .	5	.398		S.	I.	
4568	" "	10.7	" . . .	5	.336		U.	I.	
4569	" "	10.8	Mimas . . .	5	.630		U.	I.	} Mimas .6 as far as Enceladus from the ansa, and .6 of length of ansa beyond it.
4570	" "	10.9	" . . .	5	.662		P.	I.	
4571	Nov. 14	6.6	Star <i>b</i> . . .	5	.680		P.	I.	
4572	" "	6.7	Iapetus . . .	5	1.402		P.	I.	} See remark, Oct. 2. Nov. 14. Seeing 7, 7, 7.
4573	" "	6.7	" . . .	5	1.322		S.	I.	
4574	" "	6.9	Star <i>b</i> . . .	5	1.098		S.	I.	
4575	" "	7.1	" <i>b</i> . . .	5	.920		U.	I.	} See remark, Oct. 2.
4576	" "	7.2	Iapetus . . .	5	1.592		U.	I.	
4577	" "	9.3	Mimas . . .	5	.542		P.	I.	
4578	" "	9.3	" . . .	2	.455		U.	I.	[respect to ansa. Imgs. placed symm. with Achr. eye-piece, power 400. Indistinct, haze. See Oct. 2.
4579	" "	9.3	" . . .	5	.596		U.	I.	
4580	" "	9.5	" . . .	5	.524		P.	I.	
4581	Nov. 15	6.7	Star <i>b</i> . . .	5	5.170		S.	J.	} See remark, Oct. 2.
4582	" "	6.9	" <i>b</i> . . .	5	4.092		U.	J.	
4583	" "	7.0	" <i>b</i> . . .	5	3.848		P.	J.	
4584	" "	7.2	Iapetus . . .	5	1.292		P.	I.	See remark, Oct. 2.
4585	" "	7.2	Star <i>b</i> . . .	5	.868		P.	I.	
4586	" "	7.3	Titan . . .	5	3.774		P.	I.	
4587	" "	7.3	" . . .	5	4.468		U.	I.	See remark, Oct. 2.
4588	" "	7.4	Iapetus . . .	5	1.234		U.	I.	
4589	" "	7.5	Star <i>b</i> . . .	5	.724		U.	I.	
4590	Nov. 16	7.8	Iapetus . . .	5	1.390		P.	I.	See remark, Oct. 2.
4591	" "	7.9	Star <i>b</i> . . .	5	.952		P.	I.	
4592	" "	8.3	Iapetus . . .	5	1.416		S.	I.	
4593	" "	8.4	Star <i>b</i> . . .	6	1.213		S.	I.	[Brightness varying. See rem., Oct. 2. Clouds 70°, 5". Seeing 7, 2, 2. 240°, 5". Images blurred
4594	Nov. 23	7.3	Jupiter IV, I . . .	4	31.90	148.85	P.	H.	
4595	" "	7.4	" IV, I . . .	4	38.07	146.18	P.	H.	
4596	" "	8.1	Star <i>b</i> . . .	5	.930		P.	I.	Limit of visibility .75.
4597	" "	8.3	Mimas . . .	5	.890		P.	I.	
4598	" "	8.5	Iapetus . . .	5	1.140		P.	I.	
4599	" "	8.5	Hyperion . . .	5	.418		P.	I.	Limit of visibility .25. Limit of visibility .30.
4600	" "	8.7	" . . .	5	.372		S.	I.	
4601	" "	8.8	Iapetus . . .	5	.964		S.	I.	
4602	" "	8.9	Star <i>b</i> . . .	5	.994		S.	I.	See remark, Oct. 2. 250°, 15". In line, J. out 250°, 15". [of field. Nov. 24. Seeing 9, 7, 8.
4603	Nov. 24	6.1	Jupiter IV, II . . .	4	36.97	148.58	P.	H.	
4604	" "	6.1	" IV, II . . .	4	32.62	148.43	P.	H.	
4605	" "	6.3	Mimas . . .	5	.700		P.	I.	Limit of visibility .23.
4606	" "	6.6	Iapetus . . .	5	1.294		S.	I.	
4607	" "	6.7	Hyperion . . .	5	.356		S.	I.	
4608	" "	7.0	Mimas . . .	5	.784		S.	I.	Limit of visibility .26.
4609	" "	7.2	Hyperion . . .	5	.414		P.	I.	
4610	" "	7.2	Iapetus . . .	5	1.114		P.	I.	
4611	" "	7.3	Star <i>b</i> . . .	5	.876		P.	I.	} See remark, Oct. 2.
4612	" "	7.3	" <i>a</i> . . .	5	3.418		P.	I.	
4613	" "	7.4	" <i>c</i> . . .	5	.360		P.	I.	
4614	" "	7.5	Mimas . . .	1	1.02		P.	I.	Faint star between <i>a</i> & <i>b</i> . Rejected as too bright.
4615	" "	7.8	" . . .	5	.648		P.	I.	
4616	" "	7.8	Tethys . . .	5	1.526		P.	I.	
4617	" "	7.8	Dione . . .	5	1.348		P.	I.	Nos. 4615-4622. One reading of each sat- ellite in turn.
4618	" "	7.8	Enceladus . . .	5	.842		P.	I.	
4619	" "	7.8	Rhea . . .	5	1.474		P.	I.	
4620	" "	7.8	Titan . . .	5	3.030		P.	I.	
Total Number . . .				23026					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4621	Nov. 24	7.8	Hyperion . . .	5	.408		P.	I.	
4622	" "	7.8	Iapetus . . .	5	1.010		P.	I.	
4623	Nov. 26	6.8	Iapetus . . .	5	1.188		U.	I.	Imgs. blurred in this set & next.
4624	" "	6.9	Star <i>b</i> . . .	5	.898		U.	I.	{ See remark, Oct. 2.
4625	" "	7.0	" <i>b</i> . . .	5	.760		P.	I.	
4626	" "	7.1	Iapetus . . .	5	.802		P.	I.	Nov. 26. Seeing 8, 4, 3.
4627	Nov. 29	5.6	Iapetus . . .	5	.688		P.	I.	Nov. 29. Seeing 8, 5, 5.
4628	" "	5.7	Star <i>b</i> . . .	5	.660		P.	I.	See remark, Oct. 2.
4629	" "	5.7	Iapetus . . .	5	1.040		S.	I.	Clouds coming on.
4630	" "	8.8	Star <i>b</i> . . .	5	1.096		S.	I.	See remark, Oct. 2.
4631	" "	8.9	Iapetus . . .	5	1.182		S.	I.	
4632	Nov. 30	6.0	Iapetus . . .	5	1.030		S.	I.	Clouds near.
4633	" "	6.1	Star <i>b</i> . . .	5	.672		S.	I.	{ See remark, Oct. 2.
4634	" "	6.2	" <i>b</i> . . .	5	.788		P.	I.	
4635	" "	6.2	Iapetus . . .	5	1.044		P.	I.	Nov. 30. Seeing 6, 5, 7.
4636	Dec. 1	6.5	Jupiter II, III . .	4	42.30	147.20	P.	H.	210°, 25".
4637	" "	6.6	" II, III . .	4	46.05	146.70	P.	H.	210°, 25". } Barely seen.
4638	" "	6.7	" II, III . .	4	45.13	148.13	S.	H.	210°, 20". } haze.
4639	" "	6.8	" II, III . .	4	44.78	149.67	S.	H.	30°, 20". }
4640	" "	8.6	Iapetus . . .	5	.606		S.	I.	
4641	" "	8.6	" . . .	5	.944		P.	I.	
4642	" "	8.7	Star <i>b</i> . . .	5	.940		P.	I.	{ See remark, Oct. 2.
4643	" "	8.7	" <i>b</i> . . .	5	.756		S.	I.	
4644	Dec. 6	6.3	Iapetus . . .	5	.656		S.	I.	Clouds near Saturn.
4645	" "	6.4	Star <i>b</i> . . .	5	.776		S.	I.	{ See remark, Oct. 2. S.
4646	" "	6.4	" <i>b</i> . . .	5	.924		P.	I.	sees <i>b</i> more distinctly
4647	" "	6.4	Iapetus . . .	5	.666		P.	I.	than Iapetus.
4648	" "	6.5	" . . .	5	.796		U.	I.	Dec. 6. Seeing 5, 5, 5.
4649	" "	6.6	Star <i>b</i> . . .	5	.696		U.	I.	
4650	Dec. 7	6.0	Juno, δ Capricorni	5	2.470		P.	(I.)	See remark, Oct. 2.
4651	" "	6.1	" "	5	1.748		S.	(I.)	
4652	" "	6.3	Star, "	5	3.026		P.	(I.)	{ See remark, Nov. 5.
4653	" "	6.4	" "	5	1.854		S.	(I.)	
4654	Dec. 8	5.5	Jupiter II, III . .	4	40.85	145.10	P.	H.	170°, 5". Eye-piece out
4655	" "	5.6	" II, III . .	4	41.63	150.08	P.	H.	340°, 5". [between 3d & 4th settings.
4656	" "	5.6	" II, III . .	4	46.37	150.17	S.	H.	350°, 6". III looks a
4657	" "	5.7	" II, III . .	4	40.00	150.35	S.	H.	150°, 5". [little > II.
4658	" "	5.8	" II, III . .	4	45.32	149.63	S.	H.	350°, 5". III large and
4659	" "	6.2	Iapetus . . .	5	.606		P.	I.	hazy.
4660	" "	6.3	Star <i>b</i> . . .	5	.670		P.	I.	{ See remark, Oct. 2.
4661	" "	6.3	" <i>b</i> . . .	5	.794		S.	I.	
4662	" "	6.3	Iapetus . . .	5	.600		S.	I.	
4663	Dec. 11	7.4	Iapetus . . .	5	.924		U.	I.	
4664	" "	7.5	Star <i>b</i> . . .	5	1.040		U.	I.	See remark, Oct. 2.
4665	Dec. 13	6.4	Iapetus . . .	5	2.448		S.	J.	
4666	" "	6.5	Star <i>b</i> . . .	5	2.356		S.	J.	{ See remark, Oct. 2.
4667	" "	6.7	" <i>b</i> . . .	5	3.098		U.	J.	
4668	" "	6.7	Iapetus . . .	5	2.978		U.	J.	
4669	" "	6.9	" . . .	5	.780		S.	I.	
4670	" "	7.0	Star <i>b</i> . . .	5	1.066		S.	I.	{ See remark, Oct. 2.
4671	" "	7.1	" <i>b</i> . . .	5	.862		U.	I.	
4672	" "	7.2	Iapetus . . .	5	.716		U.	I.	
4673	Dec. 14	5.4	Star <i>b</i> . . .	5	.958		P.	I.	See remark, Oct. 2.
4674	" "	5.6	Iapetus . . .	5	.866		P.	I.	
4675	" "	5.6	" . . .	5	.732		S.	I.	
4676	" "	5.6	Star <i>b</i> . . .	5	.860		S.	I.	{ See remark, Oct. 2.
4677	" "	6.0	" <i>b</i> . . .	5	4.114		P.	J.	
4678	" "	6.0	Iapetus . . .	5	2.788		P.	J.	
4679	" "	6.0	" . . .	5	2.730		S.	J.	
4680	" "	6.1	Star <i>b</i> . . .	5	3.402		S.	J.	See remark, Oct. 2.
Total Number . .				23317					

No. for Reference.	Date, 1878.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4681	Dec. 16	6.0	Iapetus	5	3.330		P.	J.	Dec. 16. Seeing 8, 6, 6.
4682	" "	6.1	Star <i>b</i>	5	3.122		P.	J.	{ See remark, Oct. 2.
4683	" "	6.2	" <i>b</i>	5	4.612		S.	J.	
4684	" "	6.3	Iapetus	5	3.232		S.	J.	See remark, Oct. 2.
4685	" "	6.5	Star <i>b</i>	5	.730		P.	I.	
4686	" "	6.5	Iapetus	5	.792		P.	I.	All but 1st two sets of Dec. 16 made without driving-clock.
4687	" "	6.5	"	5	.764		S.	I.	
4688	" "	6.6	Star <i>b</i>	5	1.034		S.	I.	See remark, Oct. 2.
4689	" "	6.7	Iapetus	5	.848		U.	I.	See remark, Oct. 2.
4690	" "	6.8	Star <i>b</i>	5	1.000		U.	I.	
4691	" "	7.0	Iapetus	5	2.350		U.	J.	See remark, Oct. 2.
4692	" "	7.1	Star <i>b</i>	5	3.044		U.	J.	
4693	" "	8.6	Neptune, α Arietis	5	2.968		P.	(I.)	
4694	" "	8.7	" "	5	3.184		S.	(I.)	
4695	" "	8.8	" "	5	3.074		U.	(I.)	
4696	Dec. 17	5.2	Jupiter II, III . . .	4	40.37	151.68	P.	H.	Dec. 17. Without driving-clock. Seeing 7, 6, 4.
4697	" "	5.3	" II, III . . .	4	37.43	152.37	P.	H.	{ Focus altered Cloud coming on. III larger, but less brilliant, than II.
4698	" "	5.5	" II, III . . .	4	38.67	242.97	S.	H.	
4699	" "	5.5	" II, III . . .	4	37.03	153.43	S.	H.	Nos. 4696-99. 60°, 8'.
4700	" "	9.3	Iapetus	5	.888		P.	I.	See remark, Oct. 2.
4701	" "	9.4	Star <i>b</i>	5	.746		P.	I.	
4702	" "	9.5	Iapetus	5	.788		U.	I.	See remark, Oct. 2.
4703	" "	9.6	Star <i>b</i>	5	.744		U.	I.	
4704	" "	9.7	Iapetus	5	3.886		P.	J.	See remark, Oct. 2.
4705	" "	9.7	Star <i>b</i>	5	4.320		P.	J.	
4706	" "	9.8	Iapetus	5	3.244		U.	J.	See remark, Oct. 2.
4707	" "	9.9	Star <i>b</i>	5	3.356		U.	J.	
4708	Dec. 18	5.7	Iapetus	5	2.706		P.	J.	See remark, Oct. 2.
4709	" "	5.9	Star <i>b</i>	5	2.912		P.	J.	
4710	" "	6.0	Iapetus	5	.608		P.	I.	See remark, Oct. 2.
4711	" "	6.1	Star <i>b</i>	5	.622		P.	I.	
4712	" "	6.2	Jupiter IV	4	19.37	60.23	P.	H.	Limit of visibility.
4713	" "	6.3	" II, IV	14			P.	H.	Reap. of Jupiter II.
4714	" "	6.4	" II, IV	4	46.58	61.32	P.	H.	All but last two sets of Dec. 18 made without driving-clock.
4715	" "	6.4	" II, IV	4	45.67	60.88	P.	H.	
4716	" "	6.7	Iapetus	5	2.214		U.	J.	See remark, Oct. 2.
4717	" "	6.8	Star <i>b</i>	5	3.886		U.	J.	
4718	" "	8.3	Iapetus	5	.924		U.	I.	See remark, Oct. 2.
4719	" "	8.4	Star <i>b</i>	5	.982		U.	I.	
4720	Dec. 19	7.1	Iapetus	5	.966		U.	I.	Dec. 19. Seeing 8, 6, 6.
4721	" "	7.1	Star <i>b</i>	5	.892		U.	I.	See remark, Oct. 2.
4722	" "	7.3	Iapetus	5	2.770		U.	J.	
4723	" "	7.4	Star <i>b</i>	5	3.138		U.	J.	{ See remark, Oct. 2.
4724	" "	7.5	" <i>b</i>	5	2.770		P.	J.	
4725	" "	7.6	Iapetus	5	3.042		P.	J.	See remark, Oct. 2.
4726	" "	7.7	Star <i>b</i>	5	.674		P.	I.	
4727	" "	7.7	Iapetus	5	.698		P.	I.	[Screw slips.
4728	Dec. 20	7.7	Star <i>b</i>	5	2.778		P.	J.	See remark, Oct. 2.
4729	" "	8.0	Iapetus	5	3.116		P.	J.	Dec. 20. Seeing 7, 5, 5.
4730	" "	8.2	"	5	.772		P.	I.	See remark, Oct. 2.
4731	" "	8.2	Star <i>b</i>	5	.798		P.	I.	
4732	Dec. 22	8.2	Iapetus	5	.718		P.	I.	See remark, Oct. 2.
4733	" "	8.3	Star <i>b</i>	5	.680		P.	I.	
4734	Dec. 23	6.6	Iapetus	5	.770		P.	I.	{ See remark, Oct. 2.
4735	" "	6.6	Star <i>b</i>	5	.688		P.	I.	
4736	" "	6.7	" <i>b</i>	5	.880		U.	I.	
4737	" "	6.8	Iapetus	5	.756		U.	I.	
4738	" "	7.1	"	5	3.424		U.	J.	{ See remark, Oct. 2.
4739	" "	7.2	Star <i>b</i>	5	3.444		U.	J.	
4740	" "	7.3	" <i>b</i>	5	2.820		P.	J.	
Total Number . . .				23619					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1878-79.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4741	Dec. 23	7.4	Iapetus	5	3.592		P.	J.	
4742	Dec. 24	7.0	Iapetus	5	.938		U.	I.	
4743	" "	7.1	Star <i>b</i>	5	.918		U.	I.	{ See remark, Oct. 2.
4744	" "	7.2	" <i>b</i>	5	.810		P.	I.	
4745	" "	7.2	Iapetus	5	1.162		P.	I.	See remark, Oct. 2.
4746	" "	7.3	Star <i>b</i>	5	2.856		P.	J.	
4747	" "	7.4	Iapetus	5	3.668		P.	J.	
4748	" "	7.5	"	5	3.288		U.	J.	
4749	" "	7.6	Star <i>b</i>	5	3.730		U.	J.	{ See remark, Oct. 2.
4750	Dec. 25	6.0	Star <i>b</i>	5	4.040		P.	J.	
4751	" "	6.1	Iapetus	5	4.802		P.	J.	
4752	" "	6.2	"	5	.816		P.	I.	
4753	" "	6.3	Star <i>b</i>	5	.704		P.	I.	{ See remark, Oct. 2.
4754	" "	6.4	" <i>b</i>	5	.934		U.	I.	
4755	" "	6.5	Iapetus	5	.944		U.	I.	Barely seen, clouds.
4756	" "	7.3	"	5	3.764		U.	J.	[mark, Oct. 2.
4757	" "	7.4	Star <i>b</i>	5	3.366		U.	J.	Clouds near. See re-
4758	Dec. 26	6.2	Iapetus	5	4.030		P.	J.	Dec. 26. Seeing 8, 6, 6.
4759	" "	6.3	Star <i>b</i>	5	3.354		P.	J.	{ See remark, Oct. 2.
4760	" "	6.6	" <i>b</i>	5	3.176		U.	J.	
4761	" "	6.7	Iapetus	5	4.022		U.	J.	
4762	" "	6.8	"	5	1.260		U.	I.	
4763	" "	6.9	Star <i>b</i>	5	.980		U.	I.	{ See remark, Oct. 2.
4764	" "	7.0	" <i>b</i>	5	.754		P.	I.	
4765	" "	7.0	" <i>a</i>	5	3.354		P.	I.	
4766	" "	7.1	" <i>a</i>	5	3.598		U.	I.	
4767	" "	7.1	Iapetus	5	1.254		P.	I.	[remark, Oct. 2.
4768	Dec. 28	9.4	Iapetus	5	1.042		P.	I.	Clouds and haze. See
4769	" "	9.4	Star <i>b</i>	5	1.178		P.	I.	Dec. 29. Seeing 6, 8, 8.
4770	Dec. 29	5.9	Iapetus	5	1.064		P.	I.	See remark, Oct. 2.
4771	" "	6.0	Star <i>b</i>	5	.826		P.	I.	
4772	Dec. 30	7.7	Iapetus	5	1.064		U.	I.	{ See remark, Oct. 2.
4773	" "	7.9	Star <i>b</i>	5	.686		U.	I.	
4774	" "	7.9	" <i>b</i>	5	.856		P.	I.	
4775	" "	8.1	Iapetus	5	1.232		P.	I.	
4776	" "	8.5	"	5	3.984		U.	J.	{ See remark, Oct. 2.
4777	" "	8.5	Star <i>b</i>	5	2.976		U.	J.	
4778	Dec. 31	5.9	Star <i>b</i>	5	.898		P.	I.	
4779	" "	6.0	Iapetus	5	1.126		P.	I.	
4780	" "	6.7	"	5	1.218		U.	I.	See remark, Oct. 2.
4781	" "	6.8	Star <i>b</i>	5	.922		U.	I.	
4782	Jan. 3	5.8	Iapetus	5	1.412		S.	I.	{ See remark, Oct. 2.
4783	" "	6.1	Star <i>b</i>	5	.774		S.	I.	
4784	" "	6.1	" <i>b</i>	5	.882		P.	I.	
4785	" "	6.1	Iapetus	5	1.232		P.	I.	
4786	" "	6.3	"	5	4.200		S.	J.	Clouds coming. See re-
4787	" "	6.5	Star <i>b</i>	5	3.444		S.	J.	mark, Oct. 2.
4788	Jan. 5	5.6	Iapetus	5	1.254		S.	I.	{ See remark, Oct. 2.
4789	" "	5.8	Star <i>b</i>	5	.864		P.	I.	
4790	" "	5.9	" <i>b</i>	5	.806		S.	I.	
4791	" "	6.4	Iapetus	5	3.490		S.	J.	See remark, Oct. 2.
4792	" "	6.6	Star <i>b</i>	5	3.116		S.	J.	
4793	" "	6.7	Iapetus	5	1.138		P.	I.	
4794	Jan. 6	7.1	Iapetus	5	3.454		S.	J.	See remark, Oct. 2.
4795	" "	7.3	Star <i>b</i>	5	2.734		S.	J.	
4796	" "	7.4	Iapetus	5	1.180		S.	I.	{ See remark, Oct. 2.
4797	" "	7.5	Star <i>b</i>	5	.662		S.	I.	
4798	" "	7.5	" <i>b</i>	5	.892		P.	I.	Second set through
4799	" "	7.5	" <i>b</i>	5	.546		U.	I.	thin clouds.
4800	" "	7.8	Iapetus	5	.768		U.	I.	
Total Number . .				23919					

No. for Reference.	Date, 1879.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4801	Jan. 6	7.9	Iapetus	5	1.170		P.	I.	
4802	Jan. 7	5.9	Iapetus	5	1.672		S.	I.	Jan. 7. Seeing 7, 8, 9.
4803	" "	6.0	Star <i>b</i>	5	1.158		S.	I.	{ See remark, Oct. 2.
4804	" "	6.2	" <i>b</i>	5	1.036		P.	I.	
4805	" "	6.2	Iapetus	5	1.652		P.	I.	
4806	" "	6.4	"	5	5.670		S.	J.	
4807	" "	6.5	Star <i>b</i>	5	2.796		S.	J.	See remark, Oct. 2.
4808	" "	6.7	Iapetus	5	1.430		U.	I.	
4809	" "	6.8	Star <i>b</i>	3	.803		U.	I.	Clouds. See rem., Oct. 2.
4810	Jan. 10	5.7	Iapetus	5	.754		S.	I.	Jan. 10. Seeing 6, 3, 3.
4811	" "	5.8	Star <i>b</i>	5	.440		S.	I.	{ See remark, Oct. 2. Not quite full aperture in second set.
4812	" "	5.9	" <i>b</i>	5	.692		P.	I.	
4813	" "	5.9	Iapetus	5	1.074		P.	I.	
4814	Jan. 12	6.4	Iapetus	5	1.052		P.	I.	
4815	" "	6.5	Star <i>b</i>	5	.736		P.	I.	{ See remark, Oct. 2.
4816	" "	6.6	" <i>b</i>	5	.650		S.	I.	
4817	" "	6.7	Iapetus	5	1.026		S.	I.	
4818	" "	7.0	"	5	3.534		S.	J.	
4819	" "	7.0	Star <i>b</i>	5	2.784		S.	J.	See remark, Oct. 2.
4820	Jan. 13	7.4	Iapetus	5	2.150		U.	I.	
4821	" "	7.5	"	5	1.474		P.	I.	
4822	" "	7.6	Star <i>b</i>	5	1.154		P.	I.	{ See remark, Oct. 2.
4823	" "	7.7	" <i>b</i>	5	1.142		U.	I.	
4824	" "	8.3	Iapetus	5	1.594		S.	I.	
4825	" "	8.3	Star <i>b</i>	5	.944		S.	I.	See remark, Oct. 2.
4826	Jan. 18	5.8	Iapetus	5	3.542		S.	J.	Jan. 18. Seeing 5, 6, 5.
4827	" "	6.0	Star <i>b</i>	5	2.938		S.	J.	See remark, Oct. 2.
4828	" "	6.3	Iapetus	5	1.272		S.	I.	
4829	" "	6.4	Star <i>b</i>	5	1.228		S.	I.	{ See remark, Oct. 2.
4830	" "	6.5	" <i>b</i>	5	1.266		P.	I.	
4831	" "	6.5	Iapetus	5	1.644		P.	I.	
4832	Jan. 19	5.7	Iapetus	5	1.366		P.	I.	[large. Comp. difficult, Iapetus
4833	" "	5.9	"	5	.900		S.	I.	Seeing 4, 2, 2.
4834	" "	6.0	Star <i>b</i>	5	.576		S.	I.	{ See remark, Oct. 2.
4835	" "	6.1	" <i>b</i>	5	.768		P.	I.	
4836	" "	6.3	Iapetus	5	3.190		S.	J.	
4837	" "	6.4	Star <i>b</i>	5	2.266		S.	J.	See remark, Oct. 2.
4838	Jan. 20	5.9	Iapetus	5	1.096		P.	I.	
4839	" "	6.0	"	5	.820		S.	I.	
4840	" "	6.1	Star <i>b</i>	5	.552		S.	I.	{ See remark, Oct. 2.
4841	" "	6.1	" <i>b</i>	5	.788		P.	I.	
4842	Jan. 23	6.2	Iapetus	5	2.144		P.	I.	Jan. 23. Seeing 7, 7, 7.
4843	" "	6.3	Star <i>b</i>	5	1.100		P.	I.	{ See remark, Oct. 2.
4844	" "	6.4	" <i>b</i>	5	1.144		S.	I.	
4845	" "	6.5	Iapetus	5	1.326		S.	I.	
4846	" "	6.8	"	5	1.256		U.	I.	
4847	" "	6.9	Star <i>b</i>	5	.886		U.	I.	See remark, Oct. 2.
4848	Jan. 24	7.0	Iapetus	5	1.646		P.	I.	Hazy, images small.
4849	" "	7.0	"	5	1.558		U.	I.	Barely seen through
4850	Jan. 25	6.4	Iapetus	5	1.294		P.	I.	thick haze.
4851	" "	6.5	Star <i>b</i>	5	.806		P.	I.	{ See remark, Oct. 2.
4852	" "	6.6	" <i>b</i>	5	.570		S.	I.	
4853	" "	6.7	Iapetus	5	.816		S.	I.	Focus altered.
4854	Jan. 26	5.9	Iapetus	5	1.172		P.	I.	Twilight and cloud.
4855	" "	6.0	"	5	.762		S.	I.	
4856	" "	6.2	Star <i>b</i>	5	.458		S.	I.	{ See remark, Oct. 2.
4857	" "	6.3	" <i>b</i>	5	.694		P.	I.	
4858	Jan. 29	6.1	Iapetus	5	1.164		P.	I.	
4859	" "	6.2	"	5	.912		S.	I.	
4860	" "	6.4	Star <i>b</i>	5	.786		S.	I.	[with other images. See remark, Oct. 2. a sym.
Total Number . .				24217					

No. for Reference.	Date, 1879.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4861	Jan. 29	6.5	Star <i>b</i>	5	.836		P.	I.	<i>a</i> out of field.
4862	Jan. 30	6.2	Iapetus	5	1.104		P.	I.	Jan. 30. Seeing 6, 7, 6.
4863	" "	6.2	Star <i>b</i>	5	.904		P.	I.	{ <i>a</i> out of field. See re- mark, Oct. 2.
4864	" "	6.3	" <i>b</i>	5	.786		S.	I.	
4865	" "	6.4	Iapetus	5	1.244		S.	I.	
4866	" "	6.7	"	5	1.440		U.	I.	
4867	" "	6.7	Star <i>b</i>	5	.808		U.	I.	<i>a</i> in field, placed symm.
4868	Jan. 31	7.2	Iapetus	5	1.098		S.	I.	Jan. 31. Seeing 6, 7, 7.
4869	" "	7.3	Star <i>b</i>	5	.962		S.	I.	<i>a</i> out of field. See re- mark, Oct. 2.
4870	" "	7.4	" <i>b</i>	5	.654		U.	I.	
4871	" "	7.5	Iapetus	5	1.212		U.	I.	
4872	" "	7.5	"	5	1.158		P.	I.	
4873	" "	7.5	Star <i>b</i>	5	.920		P.	I.	See remark, Oct. 2.
4874	Feb. 3	6.4	Iapetus	5	1.232		S.	I.	
4875	" "	6.4	"	5	1.180		P.	I.	Clouds coming.
4876	Feb. 4	6.1	Iapetus	5	1.038		P.	I.	{ Prism to left & below. Feb. 4. Seeing 5, 7, 7.
4877	" "	6.2	Star <i>b</i>	5	.624		P.	I.	
4878	" "	6.4	" <i>b</i>	5	.684		S.	I.	Prism above, <i>a</i> placed
4879	" "	6.6	Iapetus	5	.526		S.	I.	Prism below. [sym.
4880	" "	6.7	"	5	.952		S.	I.	{ Prism above.
4881	" "	6.8	"	5	1.208		U.	I.	
4882	" "	6.9	"	5	.964		U.	I.	Prism below.
4883	" "	7.1	Star <i>b</i>	5	.848		U.	I.	Prism above, <i>a</i> out of
4884	Feb. 7	6.3	Iapetus	5	.832		S.	I.	field.
4885	" "	6.4	"	5	1.036		P.	I.	
4886	" "	6.6	Star <i>b</i>	5	.498		S.	I.	
4887	" "	6.7	" <i>b</i>	5	.798		U.	I.	
4888	" "	6.8	Iapetus	5	.958		U.	I.	
4889	" "	6.9	Star <i>b</i>	5	.802		S.	I.	Prism above, <i>a</i> placed
4890	" "	7.0	" <i>b</i>	5	.712		U.	I.	sym. See rem., Oct. 2.
4891	" "	7.0	" <i>b</i>	5	.800		P.	I.	
4892	" "	7.1	" <i>b</i>	5	.566		P.	I.	Prism to the left, <i>a</i> out
4893	Feb. 8	6.7	Iapetus	5	.848		P.	I.	of field. [of field.
4894	" "	6.9	Star <i>b</i>	5	.850		P.	I.	Prism to the left, <i>a</i> out
4895	Feb. 9	6.2	Iapetus	5	.888		P.	I.	Feb. 9. Seeing 4, 5, 6.
4896	" "	6.8	"	5	.900		S.	I.	Prism to the left.
4897	" "	6.9	Star <i>b</i>	5	.574		S.	I.	Prism to the left, <i>a</i> out of
4898	" "	7.0	" <i>b</i>	5	.830		P.	I.	field. See rem., Oct. 2.
4899	" "	7.0	" <i>b</i>	5	1.088		P.	I.	Prism above, <i>a</i> in field.
4900	" "	7.0	" <i>b</i>	5	.986		P.	I.	<i>a</i> out of field.
4901	" "	7.1	" <i>b</i>	5	1.014		S.	I.	<i>a</i> in field.
4902	" "	7.2	" <i>b</i>	5	.892		S.	I.	<i>a</i> out of field.
4903	Feb. 10	6.5	Iapetus	5	.800		P.	I.	[Oct. 2
4904	" "	6.6	Star <i>b</i>	5	.598		P.	I.	<i>a</i> in field. See remark,
4905	" "	6.6	" <i>b</i>	5	.656		P.	I.	<i>a</i> out of field, focus poor.
4906	Feb. 12	6.8	Iapetus	5	1.000		S.	I.	{ Prism above. Feb. 12 Seeing 7, 4, 3
4907	" "	6.9	Star <i>b</i>	5	.688		S.	I.	
4908	" "	7.0	" <i>b</i>	5	.846		U.	I.	{ Prism above, <i>a</i> placed symmetrically. Stars flickering in second set
4909	" "	7.2	Iapetus	5	.940		U.	I.	
4910	Feb. 14	6.3	Iapetus	5	.874		P.	I.	Prism above.
4911	" "	6.4	"	5	.506		S.	I.	{ Prism to left. Feb. 14. Seeing 8, 5, 6.
4912	" "	6.6	"	5	.692		S.	I.	
4913	" "	6.6	"	5	.938		P.	I.	{ Prism above.
4914	" "	6.7	Star <i>b</i>	5	.696		S.	I.	{ Prism above, <i>a</i> placed sym. See rem., Oct. 2.
4915	" "	6.8	" <i>b</i>	5	.822		P.	I.	
4916	" "	6.8	" <i>b</i>	5	.628		P.	I.	{ Prism to the left, <i>a</i> out of field.
4917	" "	6.9	" <i>b</i>	5	.400		S.	I.	
4918	" "	6.9	" <i>b</i>	5	.440		S.	I.	Prism to left, <i>a</i> in field.
4919	" "	7.0	" <i>b</i>	5	.682		U.	I.	Prism to left, <i>a</i> out of field
4920	" "	7.1	" <i>b</i>	5	.658		U.	I.	Prism above, <i>a</i> placed sym.
Total Number . .				24517					

No. for Reference.	Date, 1879.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4921	Feb. 14	7.2	Iapetus	5	.820		U.	I.	Prism above.
4922	" "	7.3	"	5	.876		U.	I.	Prism to the left.
4923	Feb. 15	6.5	Star <i>b</i>	5	.724		P.	I.	} Prism to the left, <i>a</i> in field.
4924	" "	6.6	" <i>b</i>	5	.488		S.	I.	
4925	" "	6.7	Iapetus	5	.520		S.	I.	} Prism to the left.
4926	" "	6.8	"	5	.870		P.	I.	
4927	" "	6.9	"	5	.852		S.	I.	} Prism above. Pencils exam. for coincidence.
4928	" "	6.9	"	5	1.054		P.	I.	
4929	Feb. 23	8.8	α Leonis D . . .	5	.896		P.	I.	Prism to left, A out of field.
4930	" "	8.8	" D	5	1.200		P.	I.	" above, A " "
4931	" "	8.9	" D	5	1.240		P.	I.	" to right, A " "
4932	" "	9.0	" D	5	.808		P.	I.	" below, A " "
4933	" "	9.2	" D	5	.618		S.	I.	" below, A " "
4934	" "	9.3	" D	5	1.078		S.	I.	" to right, A " "
4935	" "	9.4	" D	5	.930		S.	I.	" to left, A " "
4936	" "	9.5	" D	5	1.902		S.	I.	" above, A " "
4937	Feb. 24	9.8	α Leonis D . . .	5	1.436		S.	I.	" above, A " "
4938	" "	9.9	" D	5	.682		S.	I.	" to left, A " "
4939	" "	10.0	" D	5	.588		S.	I.	" below, A " "
4940	" "	10.1	" D	5	.854		S.	I.	" to right, A " "
4941	" "	10.3	" D	5	.890		U.	I.	" to right, A " "
4942	" "	10.5	" D	5	.818		U.	I.	" below, A " "
4943	" "	10.5	" D	5	.808		U.	I.	" to left, A " "
4944	" "	10.6	" D	5	1.108		U.	I.	" above, A " "
4945	Feb. 27	9.0	α Leonis D . . .	5	.944		U.	I.	" above, A " "
4946	" "	9.1	" D	5	.886		U.	I.	" to left, A " "
4947	" "	9.1	" D	5	.686		U.	I.	" below, A " "
4948	" "	9.2	" D	5	.694		U.	I.	" to right, A " "
4949	" "	9.3	" C	5	.632		U.	I.	" to r., A and B out.
4950	" "	9.4	" C	5	.544		U.	I.	" below, A out, B sym.
4951	" "	9.4	" C	5	.588		U.	I.	" to left, A out, B in line.
4952	" "	9.5	" C	5	.618		U.	I.	" above, A and B out.
4953	" "	9.8	" C	5	.862		S.	I.	" above, A and B out.
4954	" "	9.8	" C	5	.868		S.	I.	" above, A out, B sym.
4955	" "	9.9	" C	5	.590		S.	I.	" to left, A and B out.
4956	" "	10.0	" C	5	.534		S.	I.	" below, A and B out.
4957	" "	10.1	" C	5	.522		S.	I.	" below, A out, B sym.
4958	" "	10.2	" C	5	.950		S.	I.	" to r., A and B out.
4959	Feb. 28	8.4	α Leonis D . . .	5	1.972		P.	I.	" to right, A out of field.
4960	" "	8.5	" D	5	.732		P.	I.	" below, A out of field.
4961	" "	8.6	" D	5	.822		P.	I.	" to left, A out of field.
4962	" "	8.6	" D	5	.916		P.	I.	" above, A out of field.
4963	" "	8.8	" D	5	1.464		P.	I.	" to right, A out of field.
4964	" "	9.2	" C	5	.934		S.	I.	" to r., A and B out.
4965	" "	9.3	" C	5	1.074		S.	I.	" to r., A and B sym.
4966	" "	9.4	" C	5	.968		S.	I.	" below, A sym, B out
4967	" "	9.4	" C	5	.618		S.	I.	" below, A and B out.
4968	" "	9.5	" C	5	.540		S.	I.	" to left, A and B out.
4969	" "	9.6	" C	5	.816		S.	I.	" above, A and B out.
4970	Mar. 3	8.4	α Leonis C . . .	5	.688		U.	I.	" above, A and B out.
4971	" "	8.5	" C	5	.676		U.	I.	" to left, A and B out.
4972	" "	8.5	" C	5	.746		U.	I.	" below, A and B sym.
4973	" "	8.6	" C	5	.606		U.	I.	" below, A out, B sym.
4974	" "	8.7	" C	5	.572		U.	I.	" to r., A and B out.
4975	" "	8.8	" C	5	.676		U.	I.	" to right, A sym., B out.
4976	" "	9.2	" D	5	.554		P.	I.	Focus 2 cms. too long.
4977	" "	9.2	" D	5	.668		P.	I.	" 1 cm. too long.
4978	" "	9.3	" D	5	.884		P.	I.	" correct
4979	" "	9.3	" D	5	.808		P.	I.	" 1 cm. too short.
4980	" "	9.4	" D	5	.688		P.	I.	" 2 cms. too short.
Total Number . .				24817					

TABLE I. — JOURNAL.

No. for Reference.	Date, 1879.	Hour.	Object observed.	No. of Settings.	Reading.	Zero.	Obs.	Photo-meter.	Remarks.
4981	Mar. 3	9.6	α Leonis D . . .	5	.432		S.	I.	Focus 2 cms. too long.
4982	" "	9.7	" D . . .	5	.674		S.	I.	" 1 cm. too short.
4983	" "	9.7	" D . . .	5	.626		S.	I.	" correct.
4984	" "	9.8	" D . . .	5	.564		S.	I.	" 2 cms. too short.
4985	" "	9.9	" D . . .	5	.550		S.	I.	" 1 cm. too long.
4986	Mar. 5	9.4	α Leonis D . . .	5	.522		U.	I.	" 1 cm. too long.
4987	" "	9.5	" D . . .	5	.400		U.	I.	" 2 cms. too long.
4988	" "	9.5	" D . . .	5	.484		U.	I.	" 1 cm. too short.
4989	" "	9.6	" D . . .	5	.596		U.	I.	" correct.
4990	" "	9.6	" D . . .	5	.458		U.	I.	" 2 cms. too short.
4991	" "	9.8	" D . . .	5	.436		S.	I.	" 1 cm. too long.
4992	" "	9.9	" D . . .	5	.508		S.	I.	" 2 cms. too short.
4993	" "	10.0	" D . . .	5	.524		S.	I.	" correct.
4994	" "	10.0	" D . . .	5	.366		S.	I.	" 2 cms. too long.
4995	" "	10.1	" D . . .	5	.472		S.	I.	" 1 cm. too short.
4996	" "	10.5	θ Cass. B, α Cass. .	5	1.406		S.	I.	} θ Cass. out of field. Prism to the right.
4997	" "	10.5	" C, " .	5	1.108		S.	I.	
4998	" "	10.7	" C, " .	5	1.076		U.	I.	
4999	" "	10.7	" B, " .	5	1.480		U.	I.	} Prism to right, A and B out.
5000	Mar. 7	8.4	α Leonis C . . .	5	1.144		P.	I.	
5001	" "	8.4	" C . . .	5	.690		P.	I.	
5002	" "	8.5	" C . . .	5	.650		P.	I.	" below, A out, B sym.
5003	" "	8.5	" C . . .	5	.650		P.	I.	" below, A sym., B not.
5004	" "	8.6	" C . . .	5	.694		P.	I.	" to left, A and B out.
5005	" "	8.7	" C . . .	5	.960		P.	I.	" to left, A sym., B not.
5006	" "	8.9	" D . . .	5	.504		P.	I.	" above, A and B out.
5007	" "	9.0	" D . . .	5	.422		P.	I.	Focus 1 cm. too long.
5008	" "	9.0	" D . . .	5	.538		P.	I.	" 2 cms. too short.
5009	" "	9.1	" D . . .	5	.414		P.	I.	" correct.
5010	" "	9.1	" D . . .	5	.510		P.	I.	" 2 cms. too long.
5011	Mar. 10	7.6	α Leonis D . . .	5	.702		U.	I.	" 1 cm. too short.
5012	" "	7.7	" D . . .	5	.708		U.	I.	" 1 cm. too long.
5013	" "	7.8	" D . . .	5	.826		U.	I.	" 2 cms. too short.
5014	" "	7.8	" D . . .	5	.816		U.	I.	" correct.
5015	" "	7.9	" D . . .	5	.612		U.	I.	" 1 cm. too short.
5016	" "	8.2	" C . . .	5	1.362		P.	I.	" 2 cms. too long.
5017	" "	8.3	" C . . .	5	1.224		P.	I.	Prism to right, A and B out.
5018	" "	8.3	" C . . .	5	.900		P.	I.	" below, A and B sym.
5019	" "	8.4	" C . . .	5	.646		P.	I.	" below, A and B out.
5020	" "	8.5	" C . . .	5	.972		P.	I.	" to left, A and B out.
5021	" "	8.5	" C . . .	5	1.106		P.	I.	" to left, A and B sym.
5022	" "	8.9	θ Cass. B, α Cass. .	5	1.774		U.	I.	" above, A and B out.
5023	" "	9.0	" B, " .	5	3.014		P.	I.	θ Cass. out of field.
5024	" "	9.1	" C, " .	5	1.996		U.	I.	} θ Cass. out of field. Prism to the right throughout, and set- tings read off by U.
5025	" "	9.2	" C, " .	5	2.386		U.	I.	
5026	" "	9.3	" B, " .	5	2.248		U.	I.	
5027	" "	9.4	" B, " .	5	2.656		P.	I.	} θ Cass. out of field. Prism to the right throughout, and set- tings read off by U.
5028	Mar. 11	8.4	θ Cass. B, α Cass. .	5	1.758		S.	I.	
5029	" "	8.5	" C, " .	5	1.562		S.	I.	
5030	" "	8.6	" C, " .	5	2.104		P.	I.	} D between B and A. A out of field, behind bar.
5031	" "	8.7	" B, " .	5	2.974		P.	I.	
5032	Mar. 18	7.3	μ Cass. B, α Cass. .	5	2.386		P.	I.	
5033	" "	7.3	" B, " .	5	2.054		U.	I.	} D between B and A. A out of field, behind bar.
5034	" "	7.7	θ Cass. D, " .	5	1.008		P.	I.	
5035	" "	7.7	" B, " .	5	2.822		P.	I.	
5036	" "	7.8	" B, " .	5	3.168		U.	I.	} D between B and A. A out of field, behind bar.
5037	" "	7.8	" D, " .	5	.804		U.	I.	
Total Number . .				25102					

CHAPTER III.

CONJUNCTION OF PLANETS.

THE proximity of Saturn and Mars, Jupiter and Venus, at their conjunctions in 1877, afforded a good opportunity for comparing their relative brightness. Six hundred comparisons of Saturn and Mars were made on twenty-five nights from August 18 to November 18. In like manner, three hundred comparisons of Jupiter and Venus were made on eleven nights from October 27 to November 17. The results are given in Tables II. and III. respectively. All the observations were made with Photometer C, except sets 1 to 4, 16 to 19, and 28 to 32, inclusive, of Table II., which were made with Photometer B. No telescope was employed, as the light, even when reduced by the prisms, was more than sufficient for the most accurate comparison.

In both Tables, the first four columns give a number for reference, the number of each set in the Journal (Table I.), the date, and the hour. The next three columns give the approximate distance of the two planets, and their altitudes, in degrees. The latter were found graphically, by a device which may prove of use elsewhere. A stereographic projection of the heavens was drawn, the diameter of the sphere being taken as 40 cms. The north pole formed the centre, or the eye was placed at the south pole. Parallels were then drawn at intervals of a degree, and meridians at intervals of every four minutes. Finally, a series of circles of equal altitude was added at intervals of a degree. From this, the altitude of any object whose declination and hour angle are known may be found by simple inspection. By two additional series of circles, the azimuth and parallactic angle may be found. The triangle formed by the star, pole, and zenith, may thus be completely solved. The advantage of this projection is that, as all the circles are projected as circles or straight lines, they may be drawn both accurately and rapidly. The formulas for the constructions will be found in Appendix A.

The eighth column, headed "Light Ratio," gives a coefficient by which the light of the planets may be corrected for their different diameters and distances from the Sun. In order to compute this quantity, let d equal the polar diameter of the planet, D its distance from the Sun, and E the diameter of a circular disk having an area equal to the illuminated portion of the planet. For Venus and Mars, $E = d \sqrt{P}$, in which P denotes the phase, or versed sine, of the illuminated portion of the planet,

divided by its apparent diameter. For Jupiter, where the defective illumination is insensible, we must allow for the ellipticity; calling e the equatorial diameter divided by the polar diameter, or 1.079, $E = d \sqrt{e} = 1.039 d$. The problem becomes more complicated in the case of Saturn on account of the ring. The values of E have been computed with the aid of the table given in Zöllner's *Photometrische Untersuchungen*, p. 200.

Having thus determined E , let L equal the observed light of the planet, and l its light, if removed to a distance of unity from the Sun, and by an observer at such a distance that its diameter equals unity. Then, by the ordinary laws of photometry, $L = l \frac{E^2}{D^2}$. The values of $\frac{E^2}{D^2}$ were computed for Saturn and Mars for every twenty days during the period of observation, and the same quantities for Jupiter and Venus for every ten days. The coefficient given in the eighth column is, accordingly, obtained in Table II. by subtracting the interpolated values for Saturn of $\log \frac{E^2}{D^2}$ on the days of observation from the corresponding values for Mars; and in Table III. by subtracting the values similarly obtained for Jupiter from those for Venus. The data are those given in the British Nautical Almanac, except the diameter of Mars, which is taken as 10".10 at distance unity.

Great uncertainty exists regarding this constant. Leverrier in his tables of Mars has deduced from the Greenwich Observations the value 11".10 (*Annales de l'Observatoire de Paris*, vi. 217). This value is adopted in the British Nautical Almanac, the Berlin Jahrbuch, and the *Connaissance des Temps*. In the American Ephemeris, the diameter of Mars derived from the Washington Observations is assumed to be 10".10. On the other hand, Kaiser has shown (*Annalen der Sternwarte in Leiden*, iii. 240) that all good micrometric measurements give a value less than 10".0, the mean being about 9".4. It is hard to account for so great a difference. The diameter of Mars at its opposition in 1877 becomes 29".4 or 24".9, according as we use the value deduced by Leverrier, or the result of the micrometric measures. In the present volume, it seemed safer to adopt the intermediate value of 10".10, especially as it agrees closely with the result of observations made in 1877 with the meridian circle of this Observatory. Means will be given in the more important cases of correcting the result to correspond with either of the values named above.

A part of the discrepancy may probably be explained by irradiation and the enlargement of the disk, due to the unequal density of the air. The last effect will be less marked in micrometric observations, since they would seldom be made when the condition of the air was not good; while the same freedom in selecting a time of observation does not exist, when the instrument to be used is confined to the meridian.

The ninth column gives the mean reading, or angle between the point at which the images appeared equal and that at which the image of the brighter planet disappeared.

The tenth column gives the observed difference of the light of the two planets in stellar magnitudes. The logarithm of the relative light of the two bodies is first found by taking twice the logarithm of the tangent of the mean reading. The arithmetical complement of this quantity is then divided by 0.4. It will be noticed that Mars is at first a little more than three magnitudes brighter than Saturn; the difference increasing to about three and a half magnitudes in the latter part of August, and then diminishing to one and a half magnitudes in November.

The next column gives the logarithm of the relative *albedo*, or comparative proportion of light reflected by the two planets for an equal amount of incident light. It is found by adding the "Light Ratio" of the eighth column to the logarithm of the light, or to twice the logarithm of the tangent of the mean reading found above. When the two planets differ in altitude, a correction for difference of atmospheric absorption is theoretically necessary. This has been taken from the table on page 43 of Seidel's *Untersuchungen über die gegenseitigen Helligkeiten der Fixsterne erster Grösse und über die Extinction des Lichtes in der Atmosphäre* (München, 1852); and the following column contains the logarithm of the albedo thus corrected. The error of the observation in magnitudes is given in the thirteenth column. It is found by computing the true brightness, assuming that the corrected albedos have their mean values found below, or .665 in Table II. and 9.933 in Table III. The number in the column is the observed *minus* the computed difference in magnitudes.

The last two columns give the plane of polarization of the images, and the initial of the observer. Since the angular interval between the images formed by the double image prism could not be altered at will, but always equalled about two degrees and a half, the four images were ordinarily placed in line. This brought the two images to be compared as near together as possible. The plane of polarization of one of them always passed through the other. The planet forming this image is denoted by its initial in the last column but one. The light of the other planet is of course polarized in a plane perpendicular to the line of images. Records of this kind were made only after October 22. On the evening of November 13, after the measurements of Jupiter and Venus, there was a change in the relative position of the prisms, as is shown by the alteration in the zero on that evening (p. 23). This has introduced some uncertainty in the plane of polarization of the subsequent observations, which are therefore marked with a query. Probably the Nicol became loose, and turned in its tube; the letters given accord with this explanation. Generally each set represents the mean of ten individual settings, five on each side of the zero, or point of disappearance of the brighter planet. In Table II., set 5 consisted of only two settings, set 29 of nine, set 35 of twelve, set 39 of seven, and sets 59 to 62 of eight each.

TABLE II.

SATURN AND MARS.

No.	No. in Table I.	Date. 1877.	Hour.	Dis- tance.	Altitude.		Light Ratio.	Reading.	Diff. in Magn.	Log. Albedo.	Log. Cor. Albedo.	Resid. in Magn.	Plane Polar.	Obs.
					Sat.	Mars.								
1	74	Aug. 18	12.0	4.2	37	32	1.970	13.04	3.18	.697	.671	-.01		P.
2	75	" "	12.2	"	38	32	"	12.65	3.25	.669	.639	+.07		P.
3	76	" "	12.3	"	38	34	"	13.13	3.16	.704	.685	-.05		U.
4	77	" "	12.5	"	39	35	"	13.04	3.18	.697	.679	-.03		P.
5	106	Aug. 27	10.5	4.7	30	27	1.997	12.90	3.20	.717	.693	-.07		P.
6	111	Aug. 28	9.2	4.7	20	17	1.999	11.40	3.48	.606	.564	.00		P.
7	112	" "	9.3	"	21	18	"	11.75	3.42	.631	.593	+.18		P.
8	118	Aug. 30	11	4.9	35	32	2.000	11.40	3.48	.609	.593	+.18		P.
9	119	" "	11	"	35	32	"	10.40	3.68	.527	.511	+.39		P.
10	121	" "	12.0	"	40	35	"	10.97	3.44	.575	.553	+.29		P.
11	122	" "	12.1	"	40	35	"	12.69	3.24	.705	.683	-.04		P.
12	132	Sept. 3	9.8	5.2	29	26	1.999	12.67	3.24	.703	.677	-.03		P.
13	133	" "	10.0	"	31	27	"	12.87	3.20	.719	.688	-.06		P.
14	134	" "	10.2	"	31	27	"	13.05	3.18	.725	.694	-.07		P.
15	282	Sept. 26	10.6	7.2	40	35	1.881	14.88	2.87	.731	.609	+.09		P.
16	283	" "	10.7	"	40	35	"	13.41	3.11	.636	.614	+.13		P.
17	293	Sept. 30	9.8	7.1	39	35	1.850	13.09	3.16	.584	.562	+.26		P.
18	294	" "	9.9	"	39	35	"	16.46	2.64	.793	.771	-.26		S.
19	295	" "	10.1	"	39	35	"	13.74	3.06	.624	.602	+.16		P.
20	296	" "	10.2	"	40	35	"	16.45	2.65	.788	.766	.00		S.
21	326	Oct. 5	8.4	6.8	36	32	1.806	15.51	2.86	.663	.642	+.06		P.
22	328	" "	8.7	"	35	33	"	13.51	3.10	.567	.557	+.27		S.
23	329	" "	8.8	"	36	33	"	16.70	2.61	.760	.745	-.20		U.
24	384	Oct. 10	11.3	6.3	35	30	1.761	16.15	2.70	.682	.652	+.03		P.
25	385	" "	11.4	"	35	30	"	14.93	2.87	.611	.581	+.21		P.
26	412	Oct. 13	10.4	5.7	38	34	1.733	16.86	2.59	.696	.677	-.03		P.
27	413	" "	10.5	"	38	34	"	13.96	3.01	.527	.508	+.39		P.
28	426	Oct. 17	8.3	5.5	38	36	1.694	17.50	2.51	.691	.682	-.04		M.
29	427	" "	8.4	"	38	36	"	16.82	2.60	.654	.645	+.05		M.
30	439	" "	9.7	"	39	36	"	17.65	2.49	.697	.684	-.05		P.
31	456	Oct. 18	9.7	4.7	39	36	1.684	15.92	2.73	.593	.580	+.21		U.
32	459	" "	10.3	"	38	34	"	15.20	2.83	.552	.533	+.33		P.
33	465	Oct. 22	9.3	3.7	39	37	1.644	18.10	2.40	.673	.665	.00	S.	P.
34	466	" "	9.4	"	39	37	"	19.01	2.31	.719	.711	-.11	S.	U.
35	491	Oct. 23	8.2	3.4	38	37	1.633	17.09	2.56	.609	.605	+.15	M.	P.
36	492	" "	9.5	"	39	36	"	19.63	2.24	.736	.723	-.14	S.	U.
37	493	" "	9.8	"	38	36	"	19.52	2.25	.731	.722	-.14	S.	P.
38	504	Oct. 27	9.6	2.3	37	36	1.592	19.52	2.25	.690	.685	-.05	S.	P.
39	505	" "	9.7	"	37	36	"	19.04	2.31	.666	.661	+.01	M.	S.
40	506	" "	10.3	"	34	33	"	17.86	2.45	.610	.605	+.15	M.	P.
41	509	Oct. 28	9.8	2.0	37	35	1.581	18.39	2.39	.625	.615	+.13	S.	P.
42	510	" "	10.1	"	35	34	"	20.65	2.12	.731	.726	-.15	M.	S.
43	511	Oct. 29	7.3	1.7	37	36	1.571	20.62	2.12	.721	.716	-.13	S.	U.
44	513	Oct. 30	5.8	1.4	28	27	1.561	18.49	2.38	.610	.601	+.16	S.	P.
45	514	" "	6.2	"	31	30	"	17.26	2.53	.548	.541	+.31	S.	U.
46	521	" "	8.9	"	39	38	"	21.62	2.01	.756	.752	-.22	S.	S.
47	525	Nov. 3	5.7	0.2	29	29	1.520	13.61	3.08	.289	.289	+.94	M.	S.
48	529	Nov. 4	5.9	0.4	31	31	1.510	14.49	2.94	.335	.335	+.83	M.	S.
49	532	Nov. 6	5.8	1.1	31	32	1.490	17.79	2.47	.504	.511	+.39	S.	S.
50	535	" "	8.9	"	38	38	"	19.48	2.25	.588	.588	+.19	M.	P.
51	536	" "	9.0	"	37	38	"	19.93	2.21	.607	.611	+.14	S.	P.
52	554	Nov. 7	8.5	1.5	38	40	1.480	19.63	2.24	.583	.591	+.19	S.	P.
53	558	" "	9.1	"	37	38	"	21.99	1.97	.693	.697	-.08	S.	U.
54	564	Nov. 9	6.2	2.3	35	35	1.462	20.30	2.16	.598	.598	+.17	S.	P.

PHOTOMETRIC OBSERVATIONS.

No.	No. in Table I.	Date. 1877.	Hour.	Dis- tance.	Altitude.		Light Ratio.	Reading.	Diff. in Magn.	Log. Albedo.	Log. Cor. Albedo.	Resid. in Magn.	Plane Polar.	Obs.
					Sat.	Mars.								
55	627	Nov. 16	9.1	5.1	33	38	1.399	26.44	1.52	.791	.805	-.35	M.?	S.
56	629	" "	9.2	"	33	37	"	25.23	1.64	.744	.764	-.25	S.?	S.
57	631	" "	9.3	"	32	37	"	27.30	1.43	.825	.851	-.46	S.?	P.
58	633	" "	9.3	"	32	37	"	24.09	1.75	.700	.726	-.15	M.?	P.
59	642	Nov. 18	6.5	5.9	38	40	1.382	24.69	1.69	.707	.715	-.12	M.?	S.
60	643	" "	6.5	"	38	40	"	28.45	1.33	.848	.856	-.48	S.?	S.
61	652	" "	9.9	"	27	32	"	25.83	1.58	.751	.789	-.38	M.?	P.
62	653	" "	9.9	"	27	32	"	27.67	1.40	.822	.860	-.49	S.?	P.
Mean, excluding Nos. 47 to 51 inclusive,										.678	.665	±.16		

TABLE III.

JUPITER AND VENUS.

No.	No. in Table I.	Date. 1877.	Hour.	Dis- tance.	Altitude.		Light Ratio.	Reading.	Diff. in Magn.	Log. Albedo.	Log Cor. Albedo.	Resid. in Magn.	Plane Polar.	Obs.
					Jup.	Venus.								
1	503	Oct. 27	5.9	13.1	17	8	.787	25.03	1.66	.124	9.873	+.15	V.	P.
2	507	Oct. 28	5.7	12.1	17	11	.791	24.07	1.75	.092	9.966	-.08	J.	P.
3	508	" "	5.8	"	17	10	"	27.61	1.41	.228	.073	-.35	J.	S.
4	522	Nov. 1	5.4	8.3	18	12	.804	23.87	1.77	.097	9.982	-.12	J.	P.
5	524	Nov. 3	5.6	6.6	16	11	.810	20.96	2.08	9.978	9.868	+.16	V.	S.
6	528	Nov. 4	5.8	5.7	15	10	.814	24.00	1.76	.111	9.991	-.15	J.	S.
7	531	Nov. 6	5.6	4.1	16	11	.821	19.22	2.29	9.905	9.795	+.35	V.	S.
8	534	" "	6.3	"	11	6	"	24.36	1.72	.134	9.877	+.16	J.	U.
9	538	Nov. 7	5.4	3.6	16	13	.824	19.72	2.23	9.932	9.872	+.15	V.	P.
10	539	" "	5.6	"	15	12	"	22.37	1.92	.054	9.989	-.16	J.	P.
11	540	" "	5.7	"	14	11	"	21.51	2.02	.015	9.944	-.03	J.	S.
12	541	" "	5.9	"	13	10	"	19.09	2.30	9.903	9.824	+.27	V.	S.
13	542	" "	6.2	"	11	8	"	21.13	2.07	9.997	9.872	+.15	V.	U.
14	543	" "	6.3	"	10	7	"	23.54	1.81	.101	9.940	-.02	J.	U.
15	562	Nov. 9	5.8	2.7	13	11	.831	19.71	2.23	9.939	9.889	+.11	V.	P.
16	563	" "	5.9	"	12	10	"	20.89	2.09	9.995	9.940	-.02	J.	P.
17	565	" "	6.3	"	9	7	"	20.65	2.13	9.981	9.860	+.18	J.	P.
18	566	" "	6.4	"	8	6	"	22.12	1.96	.048	9.916	+.04	V.	P.
19	567	" "	6.6	"	7	5	"	22.41	1.93	.061	9.926	+.02	V.	S.
20	568	" "	6.7	"	6	4	"	25.25	1.63	.178	.040	-.27	J.	S.
21	569	" "	6.7	"	6	4	"	24.80	1.67	.166	.028	-.24	J.	U.
22	570	" "	6.8	"	5	3	"	22.67	1.89	.074	9.932	.00	V.	U.
23	574	Nov. 13	6.0	4.5	10	10	.848	19.45	2.27	9.941	9.941	-.02	V.	S.
24	575	" "	6.1	"	9	9	"	20.59	2.12	9.998	9.998	-.16	J.	S.
25	576	" "	6.2	"	8	8	"	20.21	2.17	9.980	9.980	-.12	J.	U.
26	577	" "	6.3	"	7	8	"	18.40	2.39	9.892	9.957	-.06	V.	U.
27	579	" "	6.3	"	7	8	"	19.90	2.21	9.965	.030	-.24	V.	P.
28	580	" "	6.4	"	7	7	"	20.69	2.11	.003	.003	-.23	J.	P.
29	636	Nov. 17	6.2	7.7	7	9	.863	14.61	2.92	9.695	9.816	+.29	V.	P.
30	637	" "	6.2	"	7	9	"	15.38	2.80	9.743	9.864	+.17	J.	P.
Mean of all,										.011	9.933	±.15		

On the evening of November 3, the distance between Saturn and Mars was only about $0^{\circ}.2$, so that to the naked eye they resembled a close double star seen through a telescope. The apparent light of Saturn was accordingly greatly diminished by the brilliancy of Mars. This shows itself in the observations of November 3 and 4, and to a less extent on November 6. Sets 47 to 51 inclusive are accordingly omitted in taking the mean. The remaining fifty-seven sets, giving equal weights to each, give the logarithm of the albedo of Saturn, corrected for difference of altitudes as .665, that of Mars being taken equal to unity. The average deviation of the individual readings is .064, which gives the probable error of the mean value, .007. The minuteness of these errors is best shown by reducing them to stellar magnitudes, when they become .16 and .02 respectively. The albedo corresponding to this logarithm is $4.62 \pm .07$. In other words, Saturn reflects nearly five times as large a proportion of the incident light as Mars. If the albedo of Saturn is taken as unity, that of Mars becomes .216, with a probable error of .003.

If the diameter of Mars at distance unity is taken equal to $11''.10$, all the values of the logarithm of the albedo must be increased by .082. The mean of the corrected albedos will therefore equal .747. The number corresponding to this logarithm is 5.59. In like manner, assuming the diameter equal to $9''.4$, the logarithms of the albedo must be diminished by .062. The mean in this case equals .603, corresponding to the ratio 4.01 in the relative albedos of the two planets. The uncertainty of the measures of the diameter of Mars is therefore much greater than that of the photometric measures here given.

The mean of the corrected logarithms of the albedo of Jupiter, that of Venus being taken as unity, derived from the thirty comparisons in Table III., is 9.933, with an average deviation of the individual sets of .060, or .15 of a magnitude. The probable error of this result is accordingly .009, or .02 of a magnitude. The albedo corresponding to the logarithm 9.933 is .86, with a probable error of .02.

The uncorrected value of the logarithm of the albedo is .678 in the case of Saturn and Mars, so that the change made by the correction is only .013. In the case of Jupiter and Venus, the uncorrected logarithm is .012, so that the change amounts to .079. This is explained by the fact that Jupiter and Venus were observed at much lower altitudes than Mars and Saturn.

A comparison of the individual values of Table III. shows that those marked J are, in general, greater than those marked V. The mean of the former is .073; of the latter, 9.822. Of the last twenty-two sets, in which the same observer measured the albedo with the plane of polarization first in one position and then in the other, the values of $J - V$ are positive in nine cases, and negative in two only.

Photometer C was modified before the first observations of November 7, by the

addition of a tube, through which all subsequent comparisons of the planets were made. The observer was thus able to hold the photometer so that the light should pass nearly normally to the surfaces of the prism. If held obliquely, the polarization by refraction caused by its surfaces might affect the result. This was probably the case with some of the earlier readings, as the distance between the planets was so great that they could not readily be compared. By inclining the photometer, they were brought nearer together. As a result, the image polarized in a plane passing through the other images would suffer more than its share of loss by reflection, or the planet whose initial is given in each set of the last column but one of Tables II. and III. would appear too faint. A similar effect might be produced in another way. The two images of a double-image prism are not usually alike; one is nearly achromatic, the other colored, and therefore larger and less perfectly defined. Since each contains the same amount of light, the first image will appear more brilliant than the second. At any rate, the two images will be unlike, and therefore a systematic error may be introduced, which will change its sign when the prisms are turned 180° , or when the letter of the last column but one changes. Still a third cause suggests itself, polarization of the light of one of the planets. It is not probable that the entire light of Saturn, Mars, or Jupiter, is perceptibly polarized in any plane; but that of Venus may be slightly polarized by reflection. If the Sun was in the line connecting Jupiter and Venus, the polarization of the latter would make the relative albedo less in those sets in which the plane of polarization of Venus passed through that of Jupiter. If the line connecting the planets was at right angles to that passing through the Sun, an opposite effect would be produced. For other angles, the direction of the Sun must be divided into its two rectangular components.

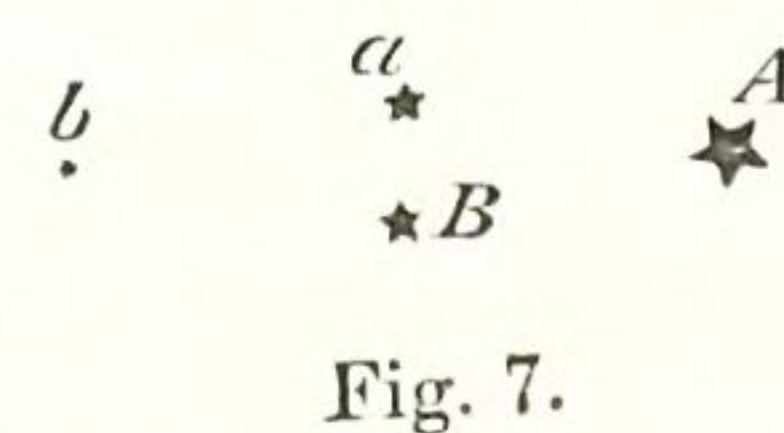
We could distinguish between these three causes as follows: The first would sensibly affect only the readings preceding November 7th, the second would affect all the readings with Photometer C equally, and the third would affect Table III. alone. It therefore seems probable that only the second cause is perceptible; and this source of error is, doubtless, almost completely eliminated in the final value.

CHAPTER IV.

BRIGHT DOUBLE STARS.

A SERIES of photometric observations has been made of all the more conspicuous double stars visible in the latitude of Cambridge. A list of objects was compiled by first selecting all the double stars in Struve's *Mensuræ Micrometricæ*, the chief components of which were at least sufficiently bright to have the magnitude 5.0. Volume I. of the Dun Echt Observatory Publications has proved most useful in this work. To these have been added many other stars, taken from various sources. Several of them are southern stars; others appear to have been overlooked by Struve, or to have been excluded from his list on account of the distance between their components. Very close doubles have been omitted, as the power used (250) was insufficient to separate them clearly. No measurements were obtained of stars much closer than $2''$, though probably with a higher power any star could be measured which could be divided with certainty. Stars having very faint companions have also been omitted, owing to the loss of light in the instrument used. No star of the Dorpat Catalogue was omitted on this account, and measurements were obtained of several stars estimated by Struve to be of the eleventh magnitude; two stars of the twelfth magnitude were also observed. Several stars were successfully measured which have been estimated by Herschel to be of the fifteenth magnitude, or even fainter.

The greater portion of these observations were made with Photometer H attached to the East Equatorial. A description of this photometer has already been given (see page 4, Figs. 1 and 2). As the objects are visible to the naked eye, the telescope was generally pointed directly upon them, without using the finding-circles. It was then set more exactly by the finder, and the object brought into the centre of the field after the clock had been put on by the cord giving the slow motion in right ascension. Two images of each component were now formed, represented by $A a$, $B b$, in Fig. 7. By rotating the double-image prism, the images could be made to turn around each other. This was done by turning the photometer. By the string attached to the prism, the latter could be moved towards or from the focus, so as to vary the distance of the images from each other. By these two motions, a could be placed in any desired position as regards B . The distances $A a$ and $A B$ were made equal whenever the



range of movement of the double-image prism allowed this to be done. It will hereafter appear that the presence of a bright image in the field at unequal distances from the images which are to be observed may seriously affect the accuracy of the comparison. Accordingly, when it was necessary to place the four images in line, the image above designated as A was ordinarily kept out of the field, although its considerable distance from the others would in any case diminish the risk of error. When the distance AB was small, the four images could be arranged in a rhombus, so that Aa and AB should be equal; and this adjustment was always carefully made. The distance at which a and B were set from each other was determined by the judgment of the observer, and depended chiefly on the character of the seeing and the brightness of the objects, varying from $3''$ to $10''$. The divided circle was first set at or near the zero of its graduation, and was turned, as a rule, so as to increase the reading, until one position in each quadrant at which a appeared of equal brightness with B had been observed. If that image which was reduced in order to bring about the equality had been the same in all four observations of each set, the estimates might all have been too large or too small; but as the images disappeared alternately, no error of this kind was to be apprehended.

From time to time, certain sources of systematic error were suspected, and precautions taken to avoid them; although, as will hereafter appear in the discussion of these observations, a want of symmetry in the position of the images, and their movement in the field during the comparisons, seem to be the only important defects to be guarded against. In order to eliminate possible errors due to the relative position of the two images compared, the practice was introduced of making them exchange places by turning the photometer between the two sets of observations made by each observer on the same evening. Soon afterwards, the additional precaution was taken of comparing, in the second set of observations, the pair of images neglected in the first set, with the object of avoiding any error which might depend upon the plane of polarization, or upon differences in the colors or forms of the four images. If in any case the companion of a bright star shines mainly by light reflected from its primary, it is probable that any effects of polarization thus occasioned would exhibit themselves in observations of it, made in the manner just described.

After May 25, 1878, the rule was adopted of recording, with each observation, the estimated direction and distance of the faint object from the reduced image of the brighter one with which it was compared. The directions were estimated with reference to the position of the observer's eye, as explained on page 11, 0° meaning that the faint object was below the other, 90° that it was toward the right, and so on. When the images were arranged in line, the faint object (B) held the same position with respect to the brighter (a), whichever pair of images was observed.

By observing the four positions of the Nicol, the index error and the error due to obliquity of the prism are eliminated. The former of these is important, since the zero, or point of disappearance, differs nearly 3° in different parts of the field, owing to the passage of the light obliquely through the Nicol. It is well shown by removing the double-image prism and turning the photometer toward a bright polished surface, reflecting light at the angle of polarization; a dark band will cross the field as the Nicol is turned past the zero. The direction of this band is inclined 45° to the plane of polarization, and on turning the Nicol 180° the band again appears at right angles to its first position. Care was taken not to move the telescope between the readings on opposite sides of the zero, when there was a great difference in the brightness of the stars to be compared. Otherwise, an error of some consequence might be produced by the change in the zero. In the earlier observations the driving-clock ran too slowly, and it was feared that the progressive change in the zero, due to the progressive motion of the star in the field, might affect the result. It is not probable that this source of error was appreciable, except possibly in the case of very faint stars.

Although the zero of the instrument is not required for the reduction of the observations, the value obtained for it from each set has been inserted in Table I., in order to show its apparent or real variations. Permanent changes occurred when the photometer was taken to pieces to clean the prisms or for other purposes. The tube carrying the double-image prism was not confined by guides, but was free to turn as well as to slide. The zero therefore altered from star to star, or whenever the prism was moved. Besides these are the changes due to errors of observation which alone affect the result.

The work of an evening was usually carried on by two observers, each of whom recorded the readings taken by the other. Four sets of observations, or sixteen settings, would thus be obtained on a single evening for each star observed. Under favorable circumstances, three stars could be measured in an hour. As each setting occupied about twenty seconds, one quarter of the time was spent in making the photometric measurements, and three quarters in moving the dome, shutters, and chair, finding and identifying the stars, adjusting the prism and other parts of the photometer, and estimating the relative positions and the distances of the images.

At least ten sets of observations, distributed over three or more nights, were taken for the measurement of each star. Any peculiarity due to the character of the seeing was thus reduced in its effect on the final result. Four or more sets were always made by myself, but care was taken that at least four should be made by the other observers, to detect any marked personal error. The close stars were frequently observed during hazy weather, the definition being much better at these times. Passing clouds do not

seem to affect the results, as the interval between the components of a double star is so small that the error from this source is not appreciable.

The method of recording the observations which proved on trial the most satisfactory is shown below. The original record, made in pencil, is here indicated by the use of Italics, while subsequent additions, in ink, are printed in Roman type. One page of the record-book is devoted to each star. The date is given at the top of the

<i>July 19, 1878.</i>			102
<i>Photometer H.</i>			
	<i>η Serpentis.</i>	<i>In line. A out of field.</i>	
<i>10 6</i>	<i>46.5</i>	<i>P. Obs. Images, 80°, 70".</i>	
	<i>49.7 3.2</i>		
	<i>226.5</i>		
	<i>230.2 3.7</i>		
	<i>552.9 6.9</i>		
	<i>276.45 3.45</i>		
	<i>138.22 1.73</i>		
<i>10 8</i>	<i>135.4</i>	<i>P. Obs. Images, 80°, 70".</i>	
	<i>138.9 3.5</i>		
	<i>316.9</i>		
	<i>321.4 4.5</i>		
	<i>912.6 8.0</i>		
	<i>456.3 4.0</i>		
	<i>228.15 2.00</i>		
<i>10 10</i>	<i>135.0</i>	<i>S. Obs. Images, 80°, 60".</i>	
	<i>139.1 4.1</i>		
	<i>316.2</i>		
	<i>321.8 5.6</i>		
	<i>912.1 9.7</i>		
	<i>456.05 4.85</i>		
	<i>228.03 2.42</i>		
<i>10 14</i>	<i>46.3</i>	<i>S. Obs. Images, 80°, 60".</i>	
	<i>50.5 4.2</i>		
	<i>226.5</i>		
	<i>230.8 4.3</i>		
	<i>554.1 8.5</i>		
	<i>277.05 4.25</i>		
	<i>138.53 2.13</i>		

page, that marking the beginning of the evening's work being underlined. Each set of four readings is separated from those next it by three lines. The time is given in the left-hand margin, and to the right is recorded the initial of the observer, followed by the relative position and the distance of the two images to be compared. The reductions, which, as a rule, were made on the day following the observations, consisted in subtracting the first reading of each set from the second, and the third from

the fourth; in adding these differences and the original readings; and finally in dividing them twice by two, which is quicker than dividing by four. The results were then copied into the Journal, given in Table I.

Table IV., which contains the Ledger of these stars, was formed from Table I. by bringing together all the observations relating to the same object. The name of each star is preceded by a number, by which it may afterwards be designated; if observed by Struve, it is followed by the symbol Σ , with the appropriate number from the Dorpat Catalogue. The results of the observations are shown in seven columns, which give a number for reference, the corresponding number of the set in Table I., the date, the mean reading, the difference of the two components in stellar magnitudes, the deviation of this result from the mean, and the initial of the observer.

TABLE IV.

LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
1. α ANDROMEDÆ. Σ 13 ^{II} . (1878.)							π ANDROMEDÆ (continued).						
1	1239	Jan. 3	1.30	8.22	-.05	P.	6	1372	Jan. 16	8.15	4.22	-.03	S.
2	1241	" "	1.22	8.35	+.08	P.	7	1430	Jan. 19	7.20	4.49	+.24	P.
3	1242	" "	1.10	8.08	-.19	S.	8	1431	" "	8.00	4.26	+.01	S.
4	1243	" "	1.27	8.26	-.01	S.	9	1432	" "	7.92	4.28	+.03	S.
5	1265	Jan. 5	1.20	8.39	+.12	S.	10	1433	" "	8.17	4.21	-.04	P.
6	1266	" "	1.25	8.31	+.04	S.					4.25	±.06	
7	1267	" "	1.15	8.49	+.22	P.	5. α CASSIOPEÆ. Σ Un. (1878.)						
8	1268	" "	1.17	8.44	+.17	P.	1	1247	Jan. 3	2.87	6.50	-.12	P.
9	1358	Jan. 16	1.40	8.06	-.21	P.	2	1248	" "	2.65	6.67	+.07	P.
10	1359	" "	1.35	8.14	-.13	P.	3	1438	Jan. 22	2.70	6.63	+.01	S.
				8.27	±.12		4	1439	" "	2.25	7.03	+.41	S.
2. α ANDROMEDÆ. Σ 13 ^{II} . (1878.) Repeated.							5	1446	Jan. 24	2.52	6.78	+.16	P.
1	3579	Aug. 23	0.70	9.56	-.25	U.	6	1447	" "	2.72	6.61	-.01	P.
2	3580	" "	0.58	9.99	+.18	U.	7	1456	" "	2.82	6.54	-.08	S.
3	3761	Sept. 8	0.62	9.81	.00	P.	8	1457	" "	3.12	6.31	-.31	S.
4	3762	" "	0.33	11.23	+1.42	P.	9	1668	Feb. 6	3.02	6.38	-.24	S.
5	3763	" "	0.75	9.41	-.41	P.	10	1669	" "	2.50	6.80	+.18	S.
6	3839	Sept. 14	0.53	10.19	+.38	S.	11	1670	" "	2.82	6.54	-.08	U.
7	3840	" "	0.97	8.85	-.96	S.	12	1671	" "	2.65	6.67	+.05	U.
8	3841	" "	0.87	9.08	-.73	P.					6.62	±.14	
9	3842	" "	0.20	12.29	+2.48	P.	6. α CASSIOPEÆ. Σ Un. (1878.) Repeated.						
10	3894	Sept. 17	0.75	9.42	-.39	U.	1	3714	Sept. 2	2.22	7.05	+.59	P.
11	3895	" "	1.10	8.08	-1.73	U.	2	3715	" "	3.15	6.30	-.16	P.
				9.81	±.81		3	3716	" "	3.85	5.86	-.60	U.
3. 51 PISCUM. Σ 36. (1877.)							4	3717	" "	2.95	6.44	-.02	U.
1	888	Dec. 14	12.12	3.39	-.21	S.	5	3738	Sept. 6	2.95	6.44	-.02	P.
2	889	" "	11.32	3.49	-.11	S.	6	3739	" "	2.93	6.45	-.01	P.
3	890	" "	11.75	3.42	-.18	U.	7	3740	" "	2.72	6.61	+.15	U.
4	891	" "	10.70	3.62	+.02	U.	8	3741	" "	3.45	6.10	-.36	U.
5	892	" "	9.52	3.88	+.28	P.	9	3767	Sept. 8	2.20	7.07	+.61	P.
6	893	" "	9.75	3.82	+.22	P.	10	3768	" "	3.33	6.17	-.29	P.
7	959	Dec. 16	9.37	3.91	+.31	P.	11	3769	" "	2.97	6.42	-.04	S.
8	960	" "	10.42	3.67	+.07	S.	12	3770	" "	2.72	6.61	+.15	S.
9	961	" "	11.82	3.39	-.21	P.					6.46	±.25	
10	962	" "	11.92	3.38	-.22	S.	7. 55 PISCUM. Σ 46. (1877-78.)						
11	1053	Dec. 23	10.70	3.62	+.02	P.	1	902	Dec. 14	12.6	3.25	-.02	P.
12	1054	" "	10.95	3.57	-.03	P.	2	903	" "	11.1	3.54	+.27	P.
				3.60	±.16		3	904	" "	11.1	3.54	+.27	S.
4. π ANDROMEDÆ. (1878.)							4	905	" "	11.4	3.48	+.21	S.
1	1327	Jan. 13	8.12	4.22	-.03	P.	5	906	" "	12.8	3.22	-.05	U.
2	1328	" "	8.42	4.15	-.10	P.	6	907	" "	12.1	3.34	+.07	U.
3	1369	Jan. 16	8.40	4.15	-.10	P.	7	1102	Dec. 25	14.2	2.99	-.28	P.
4	1370	" "	8.07	4.24	-.01	S.	8	1103	" "	13.9	3.04	-.23	P.
5	1371	" "	7.87	4.29	+.04	P.	9	1104	" "	12.2	3.32	+.05	P.

TABLE IV. — LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
55 PISCUM. Σ 46 (continued).							11. ζ PISCUM. Σ 100. (1877.)						
10	1461	Jan. 25	12.9	3.20	-.07	P.	1	894	Dec. 14	31.9	1.03	+.07	P.
11	1462	" "	12.6	3.25	-.02	S.	2	895	" "	32.5	.98	+.02	P.
12	1463	" "	13.9	3.03	-.24	P.	3	896	" "	33.6	.99	+.03	U.
13	1464	" "	12.2	3.32	+.05	S.	4	897	" "	34.6	.81	+.15	U.
				3.27	$\pm$.14		5	955	Dec. 16	31.5	1.06	+.10	P.
8. η CASSIOPELÆ. Σ 60. (1877-78.)							6	956	" "	30.5	1.15	-.19	S.
1	870	Dec. 13	8.35	4.17	+.32	U.	7	957	" "	33.5	.89	-.07	P.
2	871	" "	8.55	4.11	+.26	U.	8	958	" "	32.3	.99	+.03	S.
3	872	" "	9.25	3.94	+.09	S.	9	1051	Dec. 23	33.4	.90	-.06	P.
4	873	" "	9.12	3.97	+.12	S.	10	1052	" "	34.1	.85	-.11	P.
5	1444	Jan. 24	10.12	3.74	-.11	P.					.96	$\pm$.08	
6	1445	" "	10.12	3.74	-.11	P.	12. α URSÆ MINORIS. Σ 93. (1877-78.)						
7	1454	" "	10.80	3.60	-.25	S.	1	1088	Dec. 25	2.65	6.67	+.10	P.
8	1455	" "	10.17	3.73	-.12	S.	2	1089	" "	2.85	6.51	-.06	P.
9	1494	Jan. 26	10.07	3.75	-.10	P.	3	1090	" "	3.00	6.40	-.17	P.
10	1495	" "	10.00	3.77	-.08	P.	4	1091	" "	2.85	6.52	-.05	P.
				3.85	$\pm$.16		5	1218	Jan. 1	2.50	6.80	+.23	P.
9. ψ^1 PISCUM. Σ 88. (1877-78.)							6	1219	" "	2.57	6.74	+.17	S.
1	898	Dec. 14	41.6	.26	+.06	P.	7	1220	" "	2.60	6.71	+.14	P.
2	899	" "	41.2	.29	+.09	P.	8	1221	" "	2.85	6.52	-.05	S.
3	900	" "	39.2	.44	+.24	U.	9	1323	Jan. 13	3.00	6.40	-.17	P.
4	901	" "	40.9	.31	+.11	U.	10	1324	" "	3.05	6.37	-.20	S.
5	1100	Dec. 25	49.0	-.30	-.50	P.	11	1325	" "	2.72	6.61	+.04	P.
6	1101	" "	42.7	.18	-.02	P.	12	1326	" "	2.79	6.56	-.01	S.
7	1386	Jan. 18	42.1	.22	+.02	S.					6.57	$\pm$.12	
8	1387	" "	44.4	.04	-.16	S.	13. α URSÆ MINORIS. Σ 93. (1878.) Repeated.						
9	1388	" "	40.8	.32	+.12	P.	1	3577	Aug. 23	2.50	6.80	+.14	U.
10	1389	" "	42.3	.21	+.01	P.	2	3578	" "	2.72	6.61	-.06	U.
				+.20	$\pm$.13		3	3586	" "	3.12	6.32	-.35	S.
10. φ PISCUM. Σ 99. (1877-78.)							4	3587	" "	2.60	6.71	+.04	S.
1	908	Dec. 14	5.42	5.11	+.04	U.	5	3594	Aug. 26	2.70	6.63	-.04	U.
2	909	" "	4.97	5.30	+.23	U.	6	3595	" "	2.95	6.44	-.23	U.
3	910	" "	5.20	5.20	+.13	S.	7	3641	Aug. 29	2.67	6.66	-.01	P.
4	911	" "	4.72	5.42	+.35	S.	8	3644	" "	2.60	6.71	+.04	P.
5	912	" "	5.62	5.03	-.04	P.	9	3647	" "	2.55	6.76	+.09	U.
6	913	" "	6.00	4.89	-.18	P.	10	3650	" "	3.20	6.26	-.41	U.
7	1105	Dec. 25	5.60	5.04	-.03	P.	11	3700	Sept. 1	2.60	6.71	+.04	P.
8	1106	" "	5.20	5.20	+.13	P.	12	3702	" "	2.30	6.98	+.31	P.
9	1368	Jan. 16	5.77	4.98	-.09	P.	13	3703	" "	2.12	7.16	+.49	P.
10	1465	Jan. 25	6.20	4.82	-.25	S.	14	3704	" "	2.25	7.03	+.36	P.
11	1466	" "	6.22	4.81	-.26	P.	15	4102	Sept. 29	2.87	6.50	-.17	S.
12	1467	" "	5.45	5.10	+.03	S.	16	4105	" "	2.92	6.46	-.21	S.
13	1468	" "	5.85	4.95	-.12	P.					6.67	$\pm$.19	
				5.07	$\pm$.14		14. ψ CASSIOPELÆ A, BC. Σ 117. (1878.)						
							1	1458	Jan. 24	8.32	4.17	-.29	S.
							2	1459	" "	4.70	5.42	+.96	S.
							3	1460	" "	5.20	5.21	+.75	S.
							4	1550	Jan. 30	7.25	4.48	+.02	P.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
ψ CASSIOPELÆ A, BC. Σ 117 (continued).							γ ARIETIS. Σ 180 (continued).						
5	1551	Jan. 30	4.70	5.42	+ .96	U.	4	917	Dec. 14	47.9	-.22	-.16	U.
6	1552	" "	4.55	5.49	+1.03	U.	5	918	" "	46.2	-.09	-.03	S.
7	1553	" "	7.65	4.36	-.10	P.	6	919	" "	45.8	-.06	.00	S.
8	1554	" "	9.05	3.99	-.47	S.	7	1025	Dec. 22	43.6	+.10	+.16	P.
9	1555	" "	6.42	4.74	+.28	S.	8	1026	" "	45.7	-.05	+.01	S.
10	1662	Feb. 6	9.77	3.82	-.64	P.	9	1027	" "	43.8	+.09	+.15	P.
11	1663	" "	5.85	4.95	+.49	U.	10	1028	" "	46.9	-.14	-.08	S.
12	1664	" "	10.32	3.70	-.76	P.	11	1107	Dec. 25	43.8	+.09	+.15	P.
13	1665	" "	8.32	4.17	-.29	U.	12	1108	" "	43.7	+.10	+.16	P.
14	1666	" "	10.25	3.71	-.75	S.					-.06	$\pm .11$	
15	1667	" "	11.65	3.43	-1.03	S.	19. λ ARIETIS. Σ Un. (1877-78.)						
16	2003	Mar. 4	5.12	5.23	+.77	S.	1	1021	Dec. 22	18.4	2.39	-.12	P.
17	2004	" "	9.10	3.98	-.48	S.	2	1022	" "	18.1	2.43	-.08	S.
18	2005	" "	8.30	4.18	-.28	U.	3	1023	" "	17.6	2.49	-.02	P.
19	2006	" "	7.80	4.32	-.14	U.	4	1024	" "	18.4	2.39	-.12	S.
				4.46	$\pm .55$		5	1364	Jan. 16	16.9	2.59	+.08	P.
15. ψ CASSIOP. A, BC. Σ 117. (1878.) Repeated.							6	1365	" "	17.4	2.52	+.01	P.
1	2338	Mar. 30	6.62	4.67	-.14	P.	7	1366	" "	16.7	2.61	+.10	S.
2	2364	Mar. 31	5.82	4.96	+.15	P.	8	1367	" "	15.6	2.77	+.26	S.
3	2365	" "	6.30	4.78	-.03	S.	9	1394	Jan. 18	17.6	2.49	-.02	P.
4	2366	" "	5.85	4.95	+.14	P.	10	1395	" "	17.8	2.47	-.04	P.
5	2367	" "	5.67	5.01	+.20	S.					2.51	$\pm .09$	
6	2378	Apr. 2	6.02	4.88	+.07	P.	20. α PISCUM. Σ 202. (1877-78.)						
7	2379	" "	5.72	4.99	+.18	P.	1	695	Nov. 28	31.1	1.10	+.20	P.
8	2384	" "	6.65	4.67	-.14	S.	2	696	" "	32.4	.99	+.09	S.
9	2419	Apr. 13	7.72	4.34	-.47	S.	3	697	" "	30.8	1.12	+.22	U.
10	2420	" "	5.97	4.90	+.09	S.	4	971	Dec. 17	35.0	.78	-.12	P.
11	2421	Apr. 14	7.47	4.41	-.40	S.	5	972	" "	32.4	.99	+.09	P.
12	2422	" "	5.17	5.22	+.41	S.	6	1375	Jan. 18	35.0	.77	-.13	P.
				4.81	$\pm .20$		7	1376	" "	36.1	.68	-.22	S.
16. ψ CASSIOPELÆ A, B. Σ 117. (1878.)							8	1377	" "	33.8	.87	-.03	P.
1	2380	Apr. 2	4.50	5.52	+.16	U.	9	1378	" "	35.3	.75	-.15	S.
2	2381	" "	4.62	5.46	+.10	U.	10	1440	Jan. 24	33.5	.90	.00	P.
3	2423	Apr. 14	4.15	5.70	+.34	S.	11	1441	" "	33.3	.91	+.01	S.
4	2424	" "	6.17	4.83	-.53	S.	12	1442	" "	34.8	.79	-.11	P.
5	2425	" "	4.37	5.58	+.22	S.	13	1443	" "	31.3	1.08	+.18	S.
6	2426	" "	5.57	5.05	-.31	S.					.90	$\pm .12$	
				5.36	$\pm .28$		21. γ ANDROMEDÆ. Σ 205. (1878.)						
17. ψ CASSIOPELÆ A, C. Σ 117. (1878.)							1	1482	Jan. 25	15.2	2.83	-.02	S.
1	2382	Apr. 2	3.67	5.96	+.04	U.	2	1483	" "	14.2	2.98	+.13	P.
2	2383	" "	3.80	5.89	-.03	U.	3	1484	" "	15.2	2.83	-.02	S.
				5.92	$\pm .03$		4	1485	" "	14.8	2.89	+.04	P.
18. γ ARIETIS. Σ 180. (1877.)							5	1871	Feb. 18	15.0	2.86	+.01	P.
1	914	Dec. 14	45.1	-.01	+.05	P.	6	1872	" "	14.8	2.89	+.04	S.
2	915	" "	47.2	-.17	-.11	P.	7	1873	" "	16.6	2.63	-.22	P.
3	916	" "	49.4	-.33	-.27	U.	8	1874	" "	16.5	2.64	-.21	S.
							9	2088	Mar. 9	13.8	3.05	+.20	P.
							10	2089	" "	15.0	2.86	+.01	P.
											2.85	$\pm .09$	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
22. γ ANDROMEDÆ. Σ 205. (1878.) Through red glass.							28. γ ANDROM. Σ 205. (1878.) Indigo images.						
1	2090	Mar. 9	12.6	3.25	-.01	P.	1	4116	Sept. 30	19.3	2.28	+.54	P.
2	2091	" "	12.4	3.27	+.01	P.	2	4198	Oct. 6	20.3	2.16	+.42	P.
				3.26	$\pm .01$		3	4293	Oct. 15	37.3	.59	-1.15	S.
							4	4335	Oct. 17	22.3	1.93	+.19	U.
											1.74	$\pm .57$	
23. γ ANDROMEDÆ. Σ 205. (1878.) Through blue glass.							29. ι TRIANGULI. (1877-78.)						
1	2092	Mar. 9	16.9	2.59	-.01	P.	1	920	Dec. 14	26.4	1.52	-.04	S.
2	2093	" "	16.7	2.61	+.01	P.	2	921	" "	22.7	1.89	+.33	S.
				2.60	$\pm .01$		3	922	" "	25.9	1.57	+.01	U.
							4	923	" "	23.5	1.81	+.25	U.
							5	924	" "	25.0	1.66	+.10	P.
							6	925	" "	26.3	1.55	-.01	P.
							7	1396	Jan. 18	23.6	1.80	+.24	P.
							8	1397	" "	27.2	1.45	-.11	P.
							9	1434	Jan. 19	26.7	1.49	-.07	S.
							10	1435	" "	28.2	1.35	-.21	P.
							11	1436	" "	26.9	1.47	-.09	S.
							12	1437	" "	30.3	1.17	-.39	P.
											1.56	$\pm .15$	
24. γ ANDROMEDÆ. Σ 205. (1878.) Red images.							30. $\circ$ CETI. Σ Un. (1878.)						
1	4112	Sept. 30	13.8	3.05	-.02	P.	1	1269	Jan. 5	5.40	5.12	+.07	P.
2	4194	Oct. 6	13.5	3.10	+.03	P.	2	1270	" "	5.60	5.04	-.01	P.
3	4199	" "	13.5	3.10	+.03	S.	3	1360	Jan. 16	5.85	4.95	-.10	P.
4	4289	Oct. 15	14.1	3.00	-.07	S.	4	1361	" "	5.12	5.23	+.18	P.
5	4330	Oct. 17	13.6	3.08	+.01	U.	5	1379	Jan. 18	5.47	5.09	+.04	P.
				3.07	$\pm .03$		6	1380	" "	6.12	4.85	-.20	P.
											5.05	$\pm .10$	
25. γ ANDROM. Σ 205. (1878.) Yellow images.							31. $\circ$ CETI. Σ Un. (1878.) Repeated.						
1	4113	Sept. 30	12.7	3.23	+.09	P.	1	4336	Oct. 17	2.95	6.44	-.24	P.
2	4195	Oct. 6	15.3	2.82	-.32	P.	2	4337	" "	2.57	6.73	+.05	P.
3	4200	" "	13.8	3.15	+.01	S.	3	4338	" "	3.15	6.30	-.38	U.
4	4290	Oct. 15	14.2	2.98	-.16	S.	4	4339	" "	3.07	6.35	-.33	U.
5	4331	Oct. 17	11.3	3.50	+.36	U.	5	4368	Oct. 20	2.85	6.57	-.11	S.
				3.14	$\pm .19$		6	4369	" "	2.20	7.07	+.39	S.
							7	4370	" "	2.52	6.78	+.10	P.
							8	4371	" "	2.98	6.42	-.26	P.
							9	4400	Oct. 22	1.92	7.36	+.68	S.
							10	4401	" "	2.58	6.74	+.06	S.
											6.68	$\pm .26$	
26. γ ANDROM. Σ 205. (1878.) Green images.							32. ι CASSIOPEIÆ A, B. Σ 262. (1878.)						
1	4114	Sept. 30	19.8	2.22	-.49	P.	1	1448	Jan. 24	20.9	2.09	-.17	P.
2	4196	Oct. 6	15.6	2.77	+.06	P.	2	1449	" "	20.1	2.18	-.08	P.
3	4201	" "	14.3	2.97	+.26	S.	3	1450	" "	22.0	1.97	-.29	S.
4	4291	Oct. 15	16.5	2.64	-.07	S.	4	1451	" "	20.9	2.09	-.17	S.
5	4332	Oct. 17	14.4	2.95	+.24	U.							
				2.71	$\pm .22$								
27. γ ANDROMEDÆ. Σ 205. (1878.) Blue images.													
1	4115	Sept. 30	18.0	2.44	-.17	P.							
2	4197	Oct. 6	16.6	2.63	+.02	P.							
3	4202	" "	15.2	2.83	+.22	S.							
4	4292	Oct. 15	19.8	2.22	-.39	S.							
5	4333	Oct. 17	14.4	2.95	+.34	U.							
				2.61	$\pm .23$								

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
<i>ι</i> Cassiopele A, B. Σ 262 (continued).							36. θ Persei. Σ 296. (1878.)						
5	2022	Mar. 5	14.8	2.89	+.63	U.	1	1980	Feb. 27	4.80	5.38	-.26	P.
6	2023	" "	14.6	2.92	+.66	U.	2	1981	" "	4.40	5.57	-.07	P.
7	2028	" "	18.0	2.44	+.18	P.	3	1982	" "	4.12	5.71	+.07	S.
8	2029	" "	21.0	2.08	-.18	P.	4	1983	" "	3.72	5.93	+.29	S.
9	2199	Mar. 19	22.3	1.93	-.33	P.	5	1984	" "	3.27	6.21	+.57	U.
10	2200	" "	21.4	2.04	-.22	P.	6	1985	" "	3.55	6.04	+.40	U.
				2.26	$\pm .29$		7	2072	Mar. 8	4.85	5.38	-.26	P.
33. <i>ι</i> Cassiopele A, C. Σ 262. (1878.)							8	2073	" "	5.25	5.18	-.46	P.
1	1452	Jan. 24	12.55	3.26	-.17	S.	9	2235	Mar. 20	4.30	5.62	-.02	P.
2	1453	" "	13.30	3.14	-.29	S.	10	2236	" "	4.50	5.52	-.12	P.
3	1556	Jan. 30	11.25	3.51	+.08	P.	11	2237	" "	4.50	5.52	-.12	U.
4	2024	Mar. 5	9.75	3.82	+.39	U.	12	2238	" "	4.35	5.59	-.05	U.
5	2025	" "	10.57	3.65	+.22	U.					5.64	$\pm .22$	
6	2026	" "	10.97	3.56	+.13	P.	37. γ Ceti. Σ 299. (1877-78.)						
7	2027	" "	12.25	3.32	-.11	P.	1	1005	Dec. 20	18.5	2.38	-.09	S.
8	2201	Mar. 19	11.45	3.47	+.04	P.	2	1006	" "	15.1	2.84	+.34	S.
9	2202	" "	12.50	3.27	-.16	P.	3	1271	Jan. 5	14.3	2.97	+.50	P.
10	2203	" "	11.82	3.39	-.04	U.	4	1272	" "	19.3	2.28	-.19	P.
11	2204	" "	12.10	3.35	-.08	U.	5	1280	Jan. 6	14.5	2.94	+.47	P.
				3.43	$\pm .16$		6	1281	" "	14.9	2.88	+.41	S.
34. ν Ceti. Σ 281. (1877-78.)							7	1381	Jan. 18	17.7	2.48	+.01	P.
1	1003	Dec. 20	7.22	4.48	-.08	S.	8	1382	" "	18.0	2.44	-.03	P.
2	1004	" "	6.90	4.59	+.03	S.	9	1383	" "	18.8	2.34	-.13	P.
3	1273	Jan. 5	7.70	4.34	-.21	P.	10	1384	" "	14.2	2.98	+.51	S.
4	1362	Jan. 16	6.57	4.69	+.13	P.	11	1385	" "	20.7	2.11	-.36	S.
5	1363	" "	6.97	4.56	.00	P.	12	1390	" "	20.0	2.20	-.27	M.
6	1428	Jan. 19	7.57	4.38	-.18	P.	13	1391	" "	20.6	2.12	-.35	M.
7	1429	" "	7.62	4.37	-.19	P.	14	1392	" "	18.4	2.39	-.08	P.
8	1477	Jan. 25	6.17	4.83	+.27	P.	15	1393	" "	22.0	1.97	-.50	P.
9	1478	" "	8.20	4.21	-.35	P.	16	1416	Jan. 19	18.6	2.36	-.11	P.
10	1645	Feb. 5	6.15	4.89	+.33	U.	17	1417	" "	16.8	2.60	+.13	P.
11	1646	" "	6.30	4.78	+.22	U.	18	1418	" "	17.4	2.52	+.05	S.
				4.56	$\pm .18$		19	1419	" "	23.0	1.86	-.61	S.
35. ω Fornacis. (1878.)							20	1469	Jan. 25	19.7	2.23	-.24	P.
1	1402	Jan. 19	16.0	2.71	-.05	P.	21	1470	" "	15.8	2.74	+.27	U.
2	1403	" "	16.4	2.65	-.11	S.	22	1471	" "	18.9	2.33	-.14	U.
3	1404	" "	15.5	2.79	+.03	S.	23	1472	" "	20.7	2.11	-.36	P.
4	1405	" "	15.5	2.78	+.02	P.	24	1473	" "	18.3	2.40	-.07	P.
5	1525	Jan. 29	14.0	3.01	+.25	P.	25	1474	" "	15.3	2.82	+.35	P.
6	1526	" "	14.5	2.94	+.18	S.	26	1475	" "	14.1	3.00	+.53	U.
7	1527	" "	15.6	2.77	+.01	P.	27	1476	" "	17.2	2.55	+.08	U.
8	1528	" "	16.4	2.65	-.11	S.	28	1597	Feb. 3	21.7	2.00	-.47	P.
9	1544	Jan. 30	16.9	2.59	-.17	P.	29	1598	" "	17.7	2.48	+.01	P.
10	1545	" "	15.8	2.74	-.02	S.	30	1599	" "	18.7	2.35	-.12	P.
				2.76	$\pm .09$		31	1600	" "	19.0	2.32	-.15	P.
							32	1601	" "	15.9	2.73	+.26	S.
							33	1602	" "	16.4	2.65	+.18	S.
							34	1603	" "	16.9	2.59	+.12	S.
							35	1604	" "	18.1	2.43	-.04	S.
											2.47	$\pm .24$	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
38. η PERSEI. Σ 307. (1878.)							41 ARIETIS. Σ Un. (continued).						
1	1875	Feb. 18	6.30	4.78	+.04	P.	4	2194	Mar. 19	7.27	4.47	-.95	U.
2	1876	" "	6.72	4.64	-.10	P.	5	2247	Mar. 21	4.77	5.39	-.03	P.
3	1877	" "	7.60	4.38	-.36	U.	6	2248	" "	4.80	5.38	-.04	P.
4	1878	" "	7.62	4.37	-.37	U.	7	2249	" "	6.20	4.82	-.60	U.
5	1879	" "	6.85	4.60	-.14	S.	8	2250	" "	5.85	4.95	-.47	U.
6	1880	" "	5.20	5.20	+.46	S.	9	2293	Mar. 23	4.27	5.63	+.21	P.
7	2070	Mar. 8	5.92	4.92	+.18	P.	10	2294	" "	4.15	5.70	+.28	P.
8	2071	" "	6.15	4.84	+.10	P.	11	2360	Mar. 31	4.15	5.70	+.28	P.
9	2158	Mar. 16	6.17	4.83	+.09	P.	12	2361	" "	4.52	5.51	+.09	P.
10	2159	" "	5.72	4.99	+.25	S.	13	2362	" "	3.37	6.15	+.73	S.
11	2160	" "	6.82	4.62	-.12	P.	14	2363	" "	2.67	6.65	+1.23	S.
12	2161	" "	6.47	4.72	-.02	S.					5.42	$\pm .41$	
				4.74	$\pm .19$								
39. π ARIETIS A, B. Σ 311. (1877-78.)							42. θ ERIDANI. (1878.)						
1	1029	Dec. 22	14.6	2.92	+.01	P.	1	1557	Feb. 2	31.4	1.07	-.02	P.
2	1030	" "	14.3	2.97	+.06	S.	2	1583	Feb. 3	30.0	1.19	+.10	P.
3	1031	" "	13.3	3.13	+.22	P.	3	1584	" "	32.5	.98	-.11	S.
4	1032	" "	14.7	2.90	-.01	S.	4	1585	" "	33.6	.89	-.20	P.
5	1904	Feb. 19	15.5	2.79	-.12	P.	5	1586	" "	29.6	1.23	+.14	S.
6	1905	" "	14.3	2.97	+.06	P.	6	1611	Feb. 4	29.5	1.24	+.15	P.
7	1906	" "	15.9	2.73	-.18	S.	7	1612	" "	34.4	.82	-.27	S.
8	1907	" "	14.7	2.91	.00	U.	8	1613	" "	31.8	1.04	-.05	P.
9	1908	" "	15.4	2.80	-.11	S.	9	1614	" "	29.0	1.28	+.19	S.
10	1909	" "	13.6	3.08	+.17	U.	10	1634	Feb. 5	30.7	1.13	+.04	P.
11	2020	Mar. 5	15.3	2.81	-.10	P.	11	1635	" "	30.5	1.15	+.06	P.
12	2021	" "	15.1	2.85	-.06	P.					1.09	$\pm .12$	
				2.91	$\pm .09$								
40. π ARIETIS A, C. Σ 311. (1877-78.)							43. 2 HEV. CAMELOP. Σ 390. (1878.)						
1	1033	Dec. 22	4.45	5.54	-.25	P.	1	2251	Mar. 21	9.17	3.96	-.13	P.
2	2186	Mar. 19	3.85	5.86	+.07	P.	2	2252	" "	12.52	3.26	-.83	P.
3	2187	" "	4.50	5.52	-.27	P.	3	2253	" "	6.92	4.58	+.49	U.
4	2188	" "	3.50	6.07	+.28	U.	4	2254	" "	7.90	4.29	+.20	U.
5	2189	" "	3.90	5.83	+.04	U.	5	2322	Mar. 26	6.82	4.61	+.52	U.
6	2225	Mar. 20	5.20	5.21	-.58	P.	6	2323	" "	7.52	4.39	+.30	U.
7	2226	" "	4.10	5.72	-.07	P.	7	2324	" "	11.32	3.49	-.60	P.
8	2227	" "	3.40	6.13	+.34	U.	8	2325	" "	9.60	3.86	-.23	P.
9	2228	" "	3.40	6.13	+.34	U.	9	2519	May 2	7.52	4.40	+.31	S.
10	2314	Mar. 26	4.37	5.58	-.21	P.	10	2520	" "	8.45	4.14	+.05	S.
11	2315	" "	3.95	5.80	+.01	P.	11	2521	" "	10.67	3.62	-.47	P.
12	2316	" "	3.57	6.02	+.23	U.	12	2522	" "	9.95	3.78	-.31	P.
13	2317	" "	3.92	5.82	+.03	U.	13	2523	" "	7.00	4.56	+.47	U.
				5.79	$\pm .21$		14	2524	" "	7.67	4.35	+.26	U.
											4.09	$\pm .37$	
41. 41 ARIETIS. Σ Un. (1878.)							44. 4 HEV. CAMELOP. Σ 390. (1878.)						
1	2190	Mar. 19	5.35	5.14	-.28	P.	1	2068	Mar. 8	6.07	4.86	+.23	P.
2	2191	" "	4.55	5.49	+.07	P.	2	2069	" "	7.22	4.49	-.14	P.
3	2193	" "	5.90	4.93	-.49	U.	3	2326	Mar. 26	7.10	4.52	-.11	P.
							4	2327	" "	6.80	4.62	-.01	P.
							5	2328	" "	6.65	4.62	-.01	U.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
4 HEV. CAMELOP. Σ 390 (continued).						
6	2329	Mar. 26	6.42	4.74	+ .11	U.
7	2427	Apr. 14	7.50	4.40	- .23	S.
8	2428	" "	6.87	4.59	- .04	S.
9	2477	Apr. 21	6.77	4.62	- .01	P.
10	2478	" "	7.07	4.53	- .10	S.
11	2479	" "	6.50	4.72	+ .09	S.
12	2480	" "	6.27	4.79	+ .16	P.
				4.63	$\pm$.10	

45. α PERSEI. Σ 431. (1878.)						
1	1916	Feb. 19	5.60	5.04	+ .22	P.
2	1917	" "	6.40	4.75	- .07	P.
3	1918	" "	6.40	4.75	- .07	S.
4	1919	" "	6.47	4.72	- .10	S.
5	1920	" "	6.60	4.68	- .14	U.
6	1921	" "	6.80	4.62	- .20	U.
7	2221	Mar. 20	6.00	4.89	+ .07	P.
8	2222	" "	6.35	4.77	- .05	P.
9	2223	" "	6.20	4.82	.00	U.
10	2224	" "	6.40	4.75	- .07	U.
11	2318	Mar. 26	5.12	5.24	+ .42	P.
12	2319	" "	6.80	4.62	- .20	P.
13	2320	" "	6.17	4.83	+ .01	U.
14	2321	" "	5.57	5.05	+ .23	U.
				4.82	$\pm$.13	

46. η TAURI. Σ 81. (1878.)						
1	1885	Feb. 18	11.25	3.51	+ .26	P.
2	1886	" "	13.85	3.04	- .21	S.
3	1887	" "	12.80	3.22	- .03	P.
4	1888	" "	10.75	3.61	+ .36	S.
5	1889	" "	16.72	2.61	- .64	U.
6	1890	" "	14.25	2.97	- .28	U.
7	2152	Mar. 16	11.70	3.42	+ .17	P.
8	2153	" "	11.50	3.46	+ .21	P.
9	2213	Mar. 20	9.92	3.79	+ .54	P.
10	2214	" "	13.07	3.16	- .09	P.
11	2215	" "	14.27	2.98	- .27	U.
12	2216	" "	12.80	3.22	- .03	U.
				3.25	$\pm$.26	

47. η TAURI. Σ 81. (1878.) Repeated.						
1	2334	Mar. 30	12.2	3.32	+ .03	P.
2	2335	" "	11.2	3.52	+ .23	P.
3	2336	" "	14.1	3.00	- .29	S.
4	2337	" "	13.3	3.14	- .15	S.
5	2356	Mar. 31	10.9	3.58	+ .29	P.
6	2357	" "	10.6	3.64	+ .35	P.
7	2376	Apr. 2	11.0	3.56	+ .27	P.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
η TAURI. Σ 81 (continued).						
8	2377	Apr. 2	13.1	3.16	- .13	P.
9	2441	Apr. 18	14.0	3.02	- .27	U.
10	2442	" "	14.0	3.01	- .28	U.
				3.29	$\pm$.23	

48. 30 TAURI. Σ 452. (1877-78.)						
1	1055	Dec. 23	8.77	4.05	- .08	P.
2	1056	" "	8.55	4.12	- .01	P.
3	2229	Mar. 20	7.77	4.32	+ .19	P.
4	2230	" "	9.00	4.00	- .13	P.
5	2231	" "	8.27	4.18	+ .05	U.
6	2232	" "	9.87	3.80	- .33	U.
7	2269	Mar. 22	7.85	4.30	+ .17	P.
8	2270	" "	7.55	4.39	+ .26	P.
9	2271	" "	8.00	4.26	+ .13	U.
10	2272	" "	9.52	3.87	- .26	U.
				4.13	$\pm$.16	

49. f ERIDANI. (1878.)						
1	1412	Jan. 19	33.4	.90	+ .28	P.
2	1413	" "	39.8	.40	- .22	P.
3	1414	" "	37.7	.56	- .06	S.
4	1415	" "	36.7	.64	+ .02	S.
5	1587	Feb. 3	39.0	.46	- .16	P.
6	1588	" "	35.1	.76	+ .14	S.
7	1589	" "	38.9	.47	- .15	P.
8	1590	" "	35.4	.74	+ .12	S.
9	1615	Feb. 4	38.0	.53	- .09	P.
10	1616	" "	38.6	.49	- .13	S.
11	1617	" "	34.7	.80	+ .18	P.
12	1618	" "	36.5	.65	+ .03	S.
				.62	$\pm$.13	

50. ζ PERSEI. Σ 464. (1878.)						
1	1910	Feb. 19	3.12	6.31	+ .05	P.
2	1911	" "	3.40	6.13	- .13	P.
3	1912	" "	3.35	6.16	- .10	S.
4	1913	" "	3.22	6.25	- .01	S.
5	1914	" "	2.95	6.44	+ .18	U.
6	1915	" "	3.20	6.26	.00	U.
7	2195	Mar. 19	3.30	6.19	- .07	P.
8	2196	" "	3.02	6.39	+ .13	P.
9	2197	" "	2.77	6.57	+ .31	U.
10	2198	" "	3.22	6.24	- .02	U.
11	2217	Mar. 20	2.97	6.42	+ .16	U.
12	2218	" "	3.42	6.12	- .14	U.
13	2219	" "	3.60	6.00	- .26	P.
14	2220	" "	3.37	6.15	- .11	P.
				6.26	$\pm$.12	

TABLE IV.—LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
51. 32 ERIDANI. Σ 470. (1877-78.)							55. α TAURI. Σ 2 ^{II} . (1878.)						
1	1068	Dec. 24	29.1	1.27	-.11	P.	1	2233	Mar. 20	.75	9.41	-.12	P.
2	1069	" "	25.7	1.59	+.21	P.	2	2234	" "	.50	10.29	+.76	P.
3	1699	Feb. 11	26.6	1.50	+.12	P.	3	2273	Mar. 22	.92	8.96	-.57	U.
4	1700	" "	26.1	1.55	+.17	S.	4	2274	" "	.65	9.73	+.20	U.
5	1701	" "	26.8	1.48	+.10	P.	5	2275	" "	.62	9.81	+.28	P.
6	1702	" "	27.6	1.41	+.03	S.	6	2276	" "	.87	9.08	-.45	P.
7	1835	Feb. 16	27.6	1.41	+.03	P.	7	2339	Mar. 30	1.15	8.99	-.54	S.
8	1836	" "	29.4	1.24	-.14	S.	8	2340	" "	.80	9.27	-.26	S.
9	1837	" "	29.9	1.20	-.18	P.	9	2341	" "	.57	9.99	+.46	P.
10	1838	" "	30.6	1.14	-.24	S.	10	2358	Mar. 31	.37	9.80	+.27	P.
				1.38	$\pm$.13		11	2359	" "	.72	9.49	-.04	P.
											9.53	$\pm$.36	
52. ε PERSEI. Σ 471. (1878.)							56. 88 TAURI. (1878.)						
1	1881	Feb. 18	6.22	4.81	-.11	S.	1	2297	Mar. 23	11.37	3.48	+.03	P.
2	1882	" "	6.02	4.88	-.04	S.	2	2298	" "	13.12	3.16	-.29	P.
3	1883	" "	5.67	5.01	+.09	U.	3	2469	Apr. 21	11.22	3.52	+.07	P.
4	1884	" "	7.35	4.45	-.47	U.	4	2470	" "	12.10	3.35	-.10	P.
5	2074	Mar. 8	5.27	5.17	+.25	P.	5	2471	" "	14.25	2.98	-.47	S.
6	2075	" "	5.17	5.21	+.29	P.	6	2472	" "	8.20	4.21	+.76	S.
7	2154	Mar. 16	5.80	4.97	+.05	P.					3.45	$\pm$.29	
8	2155	" "	5.30	5.16	+.24	P.							
9	2156	" "	5.57	5.05	+.13	S.							
10	2157	" "	7.25	4.48	-.44	S.							
				4.92	$\pm$.21								
53. 39 ERIDANI. Σ 516. (1878.)							57. τ TAURI. (1878.)						
1	1591	Feb. 3	8.67	4.08	+.34	P.	1	2295	Mar. 23	14.1	3.00	+.08	P.
2	1592	" "	10.77	3.60	-.14	P.	2	2296	" "	16.0	2.71	-.21	P.
3	1900	Feb. 19	10.40	3.68	-.06	P.	3	2473	Apr. 21	11.8	3.40	+.48	P.
4	1901	" "	9.52	3.87	+.13	P.	4	2474	" "	13.3	3.14	+.22	S.
5	1902	" "	10.32	3.70	-.04	U.	5	2475	" "	17.1	2.56	-.36	P.
6	1903	" "	10.00	3.76	+.02	U.	6	2476	" "	16.1	2.70	-.22	S.
7	2007	Mar. 4	12.27	3.31	-.43	P.	7	2499	May 1	13.5	3.10	+.18	S.
8	2008	" "	11.35	3.49	-.25	P.	8	2500	" "	15.5	2.78	-.14	S.
9	2009	" "	9.32	3.92	+.18	U.	9	2501	" "	15.7	2.78	-.14	U.
10	2010	" "	9.10	3.98	+.24	U.	10	2512	May 2	13.2	3.15	+.23	U.
				3.74	$\pm$.18		11	2513	" "	15.1	2.84	-.08	U.
											2.92	$\pm$.21	
54. σ^2 40 ERIDANI A, BC. Σ 518. (1878.)							58. 7 CAMELOPARDALI. Σ 610. (1878.)						
1	1709	Feb. 11	4.85	5.36	+.09	P.	1	2330	Mar. 26	3.25	6.23	+.02	P.
2	1710	" "	4.60	5.47	+.20	U.	2	2331	" "	3.37	6.15	-.06	P.
3	1711	" "	4.52	5.51	+.24	P.	3	2332	" "	3.02	6.38	+.17	U.
4	1712	" "	5.42	5.11	-.16	U.	4	2333	" "	2.82	6.58	+.37	U.
5	1896	Feb. 19	5.70	5.00	-.27	U.	5	2481	Apr. 21	3.92	5.82	-.39	P.
6	1897	" "	6.67	4.67	-.60	U.	6	2482	" "	3.52	6.05	-.16	P.
7	1898	" "	5.02	5.28	+.01	P.	7	2483	" "	3.40	6.13	-.08	S.
8	1899	" "	4.62	5.46	+.19	P.	8	2484	" "	3.70	5.95	-.26	S.
9	2085	Mar. 9	4.85	5.38	+.11	P.	9	2569	May 6	2.92	6.46	+.25	P.
10	2086	" "	4.60	5.47	+.20	P.	10	2570	" "	3.10	6.33	+.12	P.
				5.27	$\pm$.21						6.21	$\pm$.19	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
59. ω AURIGÆ. Σ 616. (1878.)							ι LEPORIS. Σ 655 (continued.)						
1	2170	Mar. 16	17.4	2.52	-.10	P.	8	1708	Feb. 11	6.75	4.64	-.23	U.
2	2171	" "	13.5	3.10	+.48	S.	9	1713	" "	5.77	4.98	+.11	P.
3	2172	" "	14.8	2.89	+.27	P.	10	1714	" "	5.30	5.16	+.29	U.
4	2173	" "	17.2	2.55	-.07	S.	11	1715	" "	6.50	4.72	-.15	U.
5	2205	Mar. 19	20.8	2.10	-.52	U.	12	1716	" "	6.35	4.77	-.10	P.
6	2206	" "	18.4	2.39	-.23	U.	13	2054	Mar. 8	5.37	5.13	+.26	P.
7	2207	" "	17.7	2.48	-.14	P.	14	2055	" "	6.17	4.83	-.04	P.
8	2208	" "	15.1	2.84	+.22	P.	15	2056	" "	5.20	5.21	+.34	U.
9	2303	Mar. 23	16.1	2.70	+.08	P.	16	2057	" "	5.55	5.06	+.19	U.
10	2304	" "	16.3	2.67	+.05	P.					4.87	$\pm .21$	
				2.62	$\pm .22$								
60. 11, 12 CAMELOP. Σ 131. (1878.) W. Equat.							63. ρ ORIONIS. Σ 654. (1878.)						
1	3955	Sept. 19	37.1	.60	-.25	P.	1	1721	Feb. 11	9.27	3.93	+.01	S.
2	3956	" "	37.7	.56	-.29	P.	2	1722	" "	8.72	4.07	+.15	S.
3	4020	Sept. 23	31.2	1.10	+.25	P.	3	1723	" "	9.00	4.00	+.08	U.
4	4021	" "	30.8	1.12	+.27	P.	4	1724	" "	9.17	3.96	+.04	U.
5	4022	" "	33.9	.86	+.01	S.	5	1743	Feb. 13	9.12	3.97	+.05	S.
6	4023	" "	31.7	1.05	+.20	S.	6	1744	" "	9.80	3.81	-.11	S.
7	4047	Sept. 25	29.7	1.22	+.37	U.	7	1745	" "	10.00	3.77	-.15	U.
8	4048	" "	36.4	.61	-.24	U.	8	1746	" "	10.37	3.69	-.23	U.
9	4073	Sept. 27	38.5	.50	-.35	U.	9	1751	Feb. 14	8.72	4.07	+.15	P.
10	4074	" "	34.2	.84	-.01	U.	10	1752	" "	8.92	4.02	+.10	S.
				.85	$\pm .22$		11	1753	" "	9.92	3.78	-.14	P.
							12	1754	" "	9.25	3.94	+.02	S.
											3.92	$\pm .10$	
61. 19 HEV. CAMELOP. Σ 634. (1878.)							64. 14 AURIGÆ. Σ 653. (1878.)						
1	1217	Jan. 1	10.37	3.69	.00	P.	1	2166	Mar. 16	13.4	3.11	+.15	S.
2	2174	Mar. 16	11.60	3.44	-.25	P.	2	2167	" "	12.7	3.24	+.28	P.
3	2175	" "	12.22	3.32	-.37	S.	3	2168	" "	15.5	2.88	-.08	S.
4	2176	" "	9.20	3.95	+.26	P.	4	2169	" "	16.3	2.67	-.29	P.
5	2177	" "	9.87	3.79	+.10	S.	5	2209	Mar. 19	12.9	3.20	+.24	P.
6	2529	May 2	9.85	3.80	+.11	P.	6	2210	" "	13.7	3.07	+.11	P.
7	2530	" "	9.07	3.98	+.29	P.	7	2211	" "	16.2	2.68	-.28	U.
8	2531	" "	9.67	3.84	+.15	U.	8	2212	" "	15.3	2.81	-.15	U.
9	2532	" "	10.57	3.65	-.04	U.	9	2299	Mar. 23	14.2	2.99	+.03	P.
10	2533	May 3	10.77	3.60	-.09	P.	10	2300	" "	14.5	2.94	-.02	P.
11	2534	" "	9.95	3.78	+.09	P.					2.96	$\pm .16$	
12	2535	" "	10.82	3.59	-.10	U.							
13	2536	" "	11.22	3.51	-.18	U.							
				3.69	$\pm .16$								
62. ι LEPORIS. Σ 655. (1877-78.)							65. α LEPORIS. Σ 661. (1877-78.)						
1	1116	Dec. 25	5.87	4.94	+.07	P.	1	1118	Dec. 25	16.8	2.60	-.03	P.
2	1117	" "	5.07	5.26	+.39	P.	2	1119	" "	17.9	2.45	-.18	P.
3	1703	Feb. 11	7.00	4.55	-.32	P.	3	2049	Mar. 6	16.9	2.59	-.04	U.
4	1704	" "	6.75	4.64	-.23	S.	4	2050	" "	17.2	2.55	-.08	U.
5	1705	" "	7.05	4.54	-.33	P.	5	2058	Mar. 8	14.5	2.94	+.31	U.
6	1706	" "	6.77	4.62	-.25	S.	6	2059	" "	13.4	3.12	+.49	U.
7	1707	" "	5.92	4.92	+.05	U.	7	2083	Mar. 9	18.7	2.35	-.28	P.
							8	2084	" "	18.1	2.43	-.20	P.
											2.63	$\pm .20$	

TABLE IV. — LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
66. β ORIONIS. Σ 668. (1877-78.)							δ ORIONIS. Σ 14 ⁱ (continued).						
1	1114	Dec. 25	2.77	6.57	+ .32	P.	14	1732	Feb. 11	6.92	4.58	+ .23	S.
2	1115	" "	2.85	6.51	+ .26	P.	15	1809	Feb. 15	7.35	4.50	+ .15	U.
3	1717	Feb. 11	3.40	6.13	— .12	U.	16	1810	" "	9.17	3.96	— .39	U.
4	1718	" "	3.57	6.02	— .23	U.					4.35	$\pm$.46	
5	1719	" "	4.02	5.76	— .49	P.	70. δ ORIONIS. Σ 14 ⁱ . (1878.) Repeated.						
6	1720	" "	4.02	5.76	— .49	P.	1	2352	Mar. 31	6.97	4.56	+ .16	P.
7	1771	Feb. 14	2.90	6.48	+ .23	P.	2	2353	" "	7.65	4.36	— .04	P.
8	1772	" "	3.05	6.37	+ .12	U.	3	2413	Apr. 9	8.02	4.25	— .15	P.
9	1773	" "	3.05	6.37	+ .12	U.	4	2414	" "	6.92	4.58	+ .18	P.
10	1774	" "	2.80	6.55	+ .30	P.	5	2415	" "	8.47	4.13	— .27	U.
				6.25	$\pm$.27		6	2416	" "	6.77	4.62	+ .22	U.
67. β ORIONIS. Σ 668. (1878.) Repeated.							7	2417	Apr. 13	7.17	4.50	+ .10	S.
1	2350	Mar. 31	2.90	6.48	+ .19	P.	8	2418	" "	6.72	4.64	+ .24	S.
2	2351	" "	2.90	6.48	+ .19	P.	9	2445	Apr. 18	8.27	4.18	— .22	U.
3	2463	Apr. 19	3.12	6.31	+ .02	U.	10	2446	" "	6.97	4.56	+ .16	U.
4	2464	" "	3.00	6.40	+ .11	U.	11	2465	Apr. 19	8.55	4.12	— .28	U.
5	2467	Apr. 21	3.22	6.25	— .04	P.	12	2466	" "	7.75	4.33	— .07	U.
6	2468	" "	3.47	5.83	— .46	P.					4.40	$\pm$.17	
				6.29	$\pm$.17		71. λ ORIONIS A, B. Σ 738. (1878.)						
68. 23 ORIONIS. Σ 696. (1878.)							1	1747	Feb. 13	22.1	1.96	+ .06	S.
1	1499	Jan. 28	18.7	2.35	+ .23	U.	2	1748	" "	19.6	2.24	+ .34	S.
2	1500	" "	19.3	2.28	+ .16	P.	3	1749	" "	22.9	1.87	— .03	U.
3	1501	" "	19.7	2.48	+ .36	P.	4	1750	" "	22.6	1.90	.00	U.
4	1502	" "	21.1	2.07	— .05	U.	5	1805	Feb. 15	21.4	2.04	+ .14	P.
5	1725	Feb. 11	24.0	1.76	— .36	U.	6	1806	" "	23.1	1.85	— .05	P.
6	1726	" "	25.9	1.57	— .55	U.	7	1807	" "	25.5	1.61	— .29	U.
7	1727	" "	21.5	2.02	— .10	S.	8	1808	" "	26.5	1.51	— .39	U.
8	1728	" "	19.5	2.25	+ .13	S.	9	1833	Feb. 16	21.4	2.03	+ .13	P.
9	1755	Feb. 14	21.7	2.00	— .12	P.	10	1834	" "	22.3	1.99	+ .09	P.
10	1756	" "	20.1	2.18	+ .06	S.					1.90	$\pm$.15	
11	1757	" "	18.7	2.35	+ .23	P.	72. λ ORIONIS A, C. Σ 738. (1878.)						
12	1758	" "	21.0	2.08	— .04	S.	1	2243	Mar. 20	1.92	7.37	+ .20	U.
				2.12	$\pm$.20		2	2244	" "	2.07	7.20	+ .03	U.
69. δ ORIONIS. Σ 14 ⁱ . (1877-78.)							3	2245	" "	2.02	7.26	+ .09	P.
1	761	Dec. 3	6.62	4.67	+ .32	P.	4	2246	" "	2.25	7.03	— .14	P.
2	762	" "	6.87	4.59	+ .24	P.	5	2277	Mar. 22	2.55	6.76	— .41	P.
3	1112	Dec. 25	7.17	4.50	+ .15	P.	6	2278	" "	2.35	6.93	— .24	P.
4	1113	" "	6.77	4.63	+ .28	U.	7	2279	" "	1.95	7.34	+ .17	U.
5	1503	Jan. 28	12.67	3.24	— 1.11	U.	8	2280	" "	1.77	7.54	+ .37	U.
6	1504	" "	10.90	3.58	— .77	U.	9	2342	Mar. 30	1.87	7.43	+ .26	P.
7	1505	" "	7.20	4.39	+ .04	P.	10	2343	" "	2.32	6.96	— .21	P.
8	1506	" "	7.12	4.51	+ .16	P.	11	2344	" "	2.22	7.05	— .12	S.
9	1507	" "	7.52	4.40	+ .05	U.	12	2345	" "	2.12	7.15	— .02	S.
10	1508	" "	7.95	4.27	— .08	U.					7.17	$\pm$.19	
11	1729	Feb. 11	6.72	4.64	+ .29	P.							
12	1730	" "	7.22	4.48	+ .13	S.							
13	1731	" "	6.87	4.59	+ .24	P.							

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
73. θ^1 ORIONIS A, B. Σ 748. (1877-78.)							θ^1 ORIONIS B, D. Σ 748 (continued).						
1	1070	Dec. 24	28.8	1.30	-.16	S.	4	1569	Feb. 2	32.1	1.01	+.09	P.
2	1076	" "	25.6	1.60	+.14	P.	5	1763	Feb. 14	32.0	1.02	+.10	P.
3	1558	Feb. 2	26.4	1.52	+.06	S.	6	1769	" "	34.0	.86	-.06	S.
4	1565	" "	24.4	1.72	+.26	P.	7	1779	" "	33.6	.89	-.03	U.
5	1759	Feb. 14	26.7	1.49	+.03	P.	8	1803	Feb. 15	33.7	.88	-.04	P.
6	1765	" "	26.8	1.48	+.02	S.					.92	$\pm .06$	
7	1775	" "	31.2	1.12	-.34	U.							
8	1799	Feb. 15	27.3	1.43	-.03	P.							
				1.46	$\pm .13$		78. θ^1 ORIONIS C, D. Σ 748. (1877-78.)						
74. θ^1 ORIONIS A, C. Σ 748. (1877-78.)							1	1075	Dec. 24	27.2	1.44	+.23	S.
1	1071	Dec. 24	32.2	1.01	-.46	S.	2	1081	" "	29.8	1.21	.00	P.
2	1077	" "	26.1	1.55	+.08	P.	3	1564	Feb. 2	28.2	1.35	+.14	S.
3	1082	" "	28.6	1.32	-.15	S.	4	1570	" "	30.2	1.18	-.03	P.
4	1559	Feb. 2	26.1	1.55	+.08	S.	5	1764	Feb. 14	30.7	1.13	-.08	P.
5	1566	" "	24.3	1.73	+.26	P.	6	1770	" "	29.1	1.27	+.06	S.
6	1760	Feb. 14	25.7	1.59	+.12	P.	7	1780	" "	34.6	.80	-.41	U.
7	1766	" "	28.5	1.32	-.15	S.	8	1804	Feb. 15	28.5	1.33	+.12	P.
8	1776	" "	27.7	1.40	-.07	U.					1.22	$\pm .13$	
9	1800	Feb. 15	24.3	1.73	+.26	P.							
				1.47	$\pm .18$		79. θ^2 ORIONIS. Σ 16 ¹ . (1878.)						
75. θ^1 ORIONIS A, D. Σ 748. (1877-78.)							1	1513	Jan. 28	25.6	1.60	+.09	P.
1	1072	Dec. 24	16.2	2.68	+.06	S.	2	1514	" "	25.0	1.66	+.15	S.
2	1078	" "	16.1	2.70	+.08	P.	3	1515	" "	28.0	1.37	-.14	P.
3	1561	Feb. 2	16.3	2.67	+.05	S.	4	1516	" "	27.2	1.44	-.07	S.
4	1567	" "	15.6	2.77	+.15	P.	5	1733	Feb. 11	28.0	1.37	-.14	P.
5	1761	Feb. 14	17.1	2.56	-.06	P.	6	1734	" "	26.0	1.56	+.05	S.
6	1767	" "	17.1	2.56	-.06	S.	7	1735	" "	27.2	1.45	-.06	P.
7	1777	" "	19.4	2.27	-.35	U.	8	1736	" "	25.5	1.61	+.10	S.
8	1801	Feb. 15	16.0	2.71	+.09	P.	9	1781	Feb. 14	26.6	1.50	-.01	U.
				2.62	$\pm .11$		10	1782	" "	26.2	1.54	+.03	U.
76. θ^1 ORIONIS B, C. Σ 748. (1877-78.)											1.51	$\pm .08$	
1	1073	Dec. 24	40.4	.35	+.20	S.	80. ι ORIONIS. Σ 752. (1877-78.)						
2	1079	" "	45.2	-.02	-.17	P.	1	1083	Dec. 24	6.97	4.56	+.03	S.
3	1562	Feb. 2	45.0	.00	-.15	S.	2	1084	" "	6.90	4.58	+.05	P.
4	1568	" "	44.2	.06	-.09	P.	3	1085	" "	7.15	4.56	+.03	P.
5	1762	Feb. 14	46.0	-.07	-.22	P.	4	1086	" "	7.12	4.51	-.02	S.
6	1768	" "	38.4	.56	+.41	S.	5	1509	Jan. 28	6.62	4.68	+.15	P.
7	1778	" "	42.5	.19	+.04	U.	6	1510	" "	6.22	4.81	+.28	S.
8	1802	Feb. 15	43.0	.15	.00	P.	7	1511	" "	8.62	4.09	-.44	P.
				.15	$\pm .16$		8	1512	" "	7.17	4.50	-.03	S.
77. θ^1 ORIONIS B, D. Σ 748. (1877-78.)							9	1825	Feb. 15	7.42	4.42	-.11	P.
1	1074	Dec. 24	32.9	.94	+.02	S.	10	1826	" "	7.37	4.42	-.11	U.
2	1080	" "	33.0	.93	+.01	P.	11	1827	" "	6.85	4.60	+.07	U.
3	1563	Feb. 2	34.7	.80	-.12	S.	12	1828	" "	6.87	4.59	+.06	P.
											4.53	$\pm .12$	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
11 MONOCEROTIS A, B. Σ 919 (continued).							α CANIS MAJORIS (continued).						
5	2044	Mar. 5	37.7	.56	+.07	U.	9	1966	Feb. 27	.667	9.68	-.34	P.
6	2045	" "	37.0	.61	+.12	U.	10	1967	" "	.433	10.62	+.60	U.
7	2046	" "	38.8	.47	-.02	P.	11	1968	" "	.533	10.16	+.14	S.
8	2047	" "	39.4	.43	-.06	P.	12	1969	" "	.817	9.23	-.79	S.
9	2259	Mar. 21	36.8	.63	+.14	U.	13	1970	" "	.600	9.90	-.12	U.
10	2260	" "	38.9	.47	-.02	U.					10.02	$\pm .45$	
11	2261	" "	40.1	.37	-.12	P.	93. μ CANIS MAJORIS. Σ 997. (1878.)						
12	2262	" "	38.7	.48	-.01	P.							
				.49	$\pm .08$		1	2051	Mar. 6	18.7	2.35	+.03	U.
90. 11 MONOCEROTIS B, C. Σ 919. (1878.)							2	2052	" "	18.9	2.34	+.02	U.
1	2040	Mar. 5	39.0	.46	+.08	P.	3	2516	May 2	23.1	1.85	-.47	P.
2	2041	" "	41.3	.28	-.10	P.	4	2517	" "	19.9	2.21	-.11	P.
3	2042	" "	35.7	.72	+.34	U.	5	2518	" "	19.8	2.22	-.10	S.
4	2043	" "	38.5	.50	+.12	U.	6	2571	May 7	15.8	2.74	+.42	U.
5	2255	Mar. 21	41.2	.29	-.09	P.	7	2572	" "	18.6	2.36	+.04	P.
6	2256	" "	41.8	.24	-.14	P.	8	2573	" "	20.3	2.16	-.16	P.
7	2257	" "	37.0	.61	+.23	U.	9	2574	" "	16.5	2.64	+.32	U.
8	2258	" "	37.0	.62	+.24	U.					2.32	$\pm .19$	
9	2305	Mar. 23	44.2	.06	-.32	P.	94. λ GEMINORUM. Σ 1061. (1878.)						
10	2514	May 2	40.0	.29	-.09	P.	1	2120	Mar. 15	2.82	6.53	+.51	U.
11	2515	" "	43.6	.10	-.28	P.	2	2121	" "	2.97	6.42	+.40	U.
				.38	$\pm .18$		3	2182	Mar. 16	3.40	6.13	+.11	P.
91. ε GEMINORUM. (1878.)							4	2183	" "	3.57	6.02	.00	P.
1	2372	Mar. 31	3.07	6.35	+.51	P.	5	2184	" "	4.17	5.68	-.34	S.
2	2373	" "	4.02	5.76	-.08	S.	6	2185	" "	4.15	5.70	-.32	S.
3	2374	" "	3.47	5.83	-.01	P.	7	2306	Mar. 25	3.00	6.40	+.38	U.
4	2375	" "	5.45	5.10	-.74	S.	8	2307	" "	3.17	6.28	+.26	U.
5	2447	Apr. 18	3.87	5.85	+.01	U.	9	2368	Mar. 31	4.25	5.65	-.37	P.
6	2448	" "	3.82	5.87	+.03	U.	10	2369	" "	3.85	5.86	-.16	P.
7	2449	" "	4.50	5.52	-.32	S.	11	2370	" "	3.87	5.84	-.18	S.
8	2450	" "	4.92	5.32	-.52	S.	12	2371	" "	4.17	5.68	-.34	S.
9	2485	Apr. 21	2.92	6.46	+.62	P.					6.02	$\pm .28$	
10	2486	" "	3.92	5.82	-.02	S.	95. δ GEMINORUM. Σ 1066. (1878.)						
11	2487	" "	3.35	6.16	+.32	P.	1	1867	Feb. 18	6.82	4.61	+.14	P.
12	2488	" "	3.55	6.04	+.20	S.	2	1868	" "	6.15	4.84	+.37	P.
				5.84	$\pm .28$		3	1869	" "	7.35	4.45	-.02	U.
92. α CANIS MAJORIS. (1877-78.)							4	1870	" "	7.27	4.47	.00	U.
1	1087	Dec. 24	.400	10.78	+.76	P.	5	2118	Mar. 15	9.17	3.96	-.51	U.
2	1651	Feb. 5	.710	9.54	-.48	P.	6	2119	" "	8.42	4.14	-.33	U.
3	1652	" "	.200	[12.29]		P.	7	2178	Mar. 16	7.35	4.45	-.02	P.
4	1891	Feb. 19	.417	10.69	+.67	P.	8	2179	" "	6.47	4.73	+.26	S.
5	1892	" "	.817	9.23	-.79	P.	9	2180	" "	6.77	4.62	+.15	P.
6	1893	" "	.550	10.10	+.08	S.	10	2181	" "	7.45	4.42	-.05	S.
7	1894	" "	.467	10.45	+.43	U.					4.47	$\pm .18$	
8	1895	" "	.617	9.84	-.18	U.							

TABLE IV.—LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
96. α GEMINORUM A, B. Σ 1110. (1878.)							100. π GEMINORUM. Σ 1135. (1878.)						
1	1813	Feb. 15	33.3	.91	+.09	U.	1	1861	Feb. 18	5.40	5.12	-.43	S.
2	1814	" "	31.8	1.04	+.22	U.	2	1862	" "	4.82	5.37	-.18	S.
3	1839	Feb. 16	38.2	.52	-.30	S.	3	1863	" "	5.05	5.27	-.28	U.
4	1840	" "	40.0	.38	-.44	S.	4	1864	" "	5.32	5.15	-.40	U.
5	1841	" "	37.3	.59	-.23	U.	5	1865	" "	4.75	5.40	-.15	P.
6	1842	" "	36.5	.66	-.16	U.	6	1866	" "	4.92	5.32	-.23	P.
7	1843	" "	31.2	1.09	+.27	P.	7	2489	Apr. 21	4.10	5.72	+.17	P.
8	1844	" "	33.5	.99	+.17	P.	8	2490	" "	4.07	5.71	+.16	P.
9	1853	Feb. 18	31.8	1.04	+.22	P.	9	2491	" "	4.42	5.56	+.01	S.
10	1854	" "	32.5	.98	+.16	P.	10	2492	" "	3.85	5.86	+.31	S.
				.82	$\pm .23$		11	2565	May 6	3.55	6.04	+.49	U.
97. α GEMINORUM A, C. Σ 4 ^{II} . (1878.)							12	2566	" "	3.62	5.99	+.44	U.
1	1855	Feb. 18	2.15	7.13	+.22	P.	13	2567	" "	4.42	5.56	+.01	P.
2	1856	" "	2.92	6.46	-.45	S.	14	2568	" "	4.17	5.68	+.13	P.
3	1857	" "	1.92	7.37	+.46	P.				5.55	$\pm .24$		
4	1858	" "	2.57	6.74	-.17	S.	101. ζ CANCRI AB, C. Σ 1196. (1877-78.)						
5	1859	" "	2.55	6.76	-.15	U.	1	1132	Dec. 26	32.9	.95	+.02	P.
6	1860	" "	2.20	7.08	+.17	U.	2	1133	" "	34.2	.84	-.09	P.
7	2451	Apr. 18	2.97	6.42	-.49	S.	3	1815	Feb. 15	33.1	.93	.00	U.
8	2452	" "	2.45	6.84	-.07	S.	4	1816	" "	33.5	.99	+.06	U.
9	2453	" "	2.37	6.91	.00	U.	5	1817	" "	33.9	.86	-.07	S.
10	2454	" "	2.37	6.91	.00	U.	6	1818	" "	31.8	1.04	+.11	S.
11	2493	Apr. 21	2.02	7.26	+.35	P.	7	1819	" "	32.5	.98	+.05	P.
12	2494	" "	2.27	7.00	+.09	P.	8	1820	" "	34.5	.82	-.11	P.
				6.91	$\pm .22$		9	2122	Mar. 15	34.2	.84	-.09	P.
98. α PUPPIS. (1878.)							10	2123	" "	35.4	.74	-.19	P.
1	2094	Mar. 9	46.4	-.10	-.11	P.	11	2124	" "	31.6	1.05	+.12	U.
2	2095	" "	45.9	-.07	-.08	P.	12	2125	" "	31.4	1.07	+.14	U.
3	2508	May 2	46.7	-.13	-.14	P.				.93	$\pm .09$		
4	2509	" "	47.0	-.15	-.16	P.	102. ι CANCRI. Σ 1268. (1878.)						
5	2510	" "	41.0	.31	+.30	U.	1	2308	Mar. 25	15.4	2.80	+.27	U.
6	2511	" "	43.6	.10	+.09	U.	2	2309	" "	18.1	2.43	-.10	U.
7	2557	May 6	45.0	.00	-.01	P.	3	2429	Apr. 16	18.5	2.38	-.15	S.
8	2558	" "	47.4	-.18	-.19	P.	4	2430	" "	17.3	2.53	.00	S.
9	2559	" "	42.9	.16	+.15	U.	5	2431	" "	19.1	2.30	-.23	U.
10	2560	" "	42.7	.18	+.17	U.	6	2432	" "	19.3	2.28	-.25	U.
				.01	$\pm .14$		7	2495	Apr. 24	17.0	2.57	+.04	P.
99. α GEMINORUM. (1878.)							8	2496	" "	15.9	2.73	+.20	P.
1	2439	Apr. 17	4.10	5.72	+.03	S.	9	2497	" "	18.2	2.41	-.12	U.
2	2440	" "	3.82	5.87	+.18	S.	10	2498	" "	15.3	2.82	+.29	U.
3	2561	May 6	3.70	5.95	+.26	U.				2.53	$\pm .17$		
4	2562	" "	4.45	5.54	-.15	U.	103. ϵ HYDRÆ. Σ 1273. (1878.)						
5	2563	" "	5.27	5.17	-.52	P.	1	2104	Mar. 10	12.1	3.34	+.10	P.
6	2554	" "	3.97	5.79	+.10	P.	2	2105	" "	11.2	3.52	+.28	P.
7	2623	May 11	4.72	5.41	-.28	P.	3	2126	Mar. 15	14.7	2.91	-.33	P.
8	2624	" "	4.20	5.67	-.02	S.	4	2127	" "	17.6	2.49	-.75	P.
9	2625	" "	3.65	5.98	+.29	P.	5	2128	" "	12.4	3.29	+.05	U.
10	2626	" "	3.87	5.84	+.15	S.	6	2129	" "	12.1	3.34	+.10	U.
				5.69	$\pm .20$		7	2263	Mar. 21	13.1	3.17	-.07	P.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
ϵ HYDRÆ. Σ 1273 (continued).							23 ι URSÆ MAJORIS. Σ 1351 (continued).						
8	2264	Mar. 21	11.7	3.42	+.18	P.	5	2641	May 13	5.02	5.28	-.01	S.
9	2265	" "	12.0	3.36	+.12	U.	6	2642	" "	5.30	5.16	-.13	S.
10	2266	" "	11.2	3.52	+.28	U.	7	2643	" "	4.95	5.31	+.02	U.
				3.24	$\pm .23$		8	2644	" "	4.72	5.41	+.12	U.
104. ι URSÆ MAJORIS. (1878.)							9	2693	May 19	4.57	5.48	+.19	P.
1	2645	May 13	2.37	6.91	-.16	U.	10	2694	" "	5.60	5.04	-.25	P.
2	2646	" "	2.10	7.18	+.11	U.					5.29	$\pm .12$	
3	2851	June 12	1.95	7.34	+.27	U.	108. α LEONIS. Σ 6 ^h . (1878.)						
4	2852	" "	2.45	6.84	-.23	U.	1	2459	Apr. 18	5.17	5.21	-.38	U.
				7.07	$\pm .19$		2	2460	" "	4.62	5.46	-.13	U.
105. σ^2 URSÆ MAJORIS. Σ 1306. (1878.)							3	2602	May 10	3.55	6.04	+.55	P.
1	2639	May 13	10.2	3.72	+.44	U.	4	2603	" "	3.30	6.15	+.46	P.
2	2640	" "	9.4	3.91	+.63	U.	5	2604	" "	4.17	5.68	+.09	U.
3	2847	June 12	15.1	2.84	-.44	S.	6	2605	" "	4.57	5.48	-.11	U.
4	2848	" "	13.2	3.15	-.13	S.	7	2669	May 18	4.17	5.68	+.09	P.
5	2849	" "	10.2	3.73	+.45	U.	8	2670	" "	5.07	5.26	-.33	S.
6	2850	" "	10.4	3.68	+.40	U.	9	2671	" "	5.47	5.09	-.50	S.
7	2991	June 24	15.4	2.80	-.48	P.	10	2672	" "	3.85	5.86	+.27	P.
8	2992	" "	14.2	2.98	-.30	P.					5.59	$\pm .29$	
9	2993	" "	11.1	3.54	+.26	S.	109. α LEONIS. Σ 6 ^h . (1878.) W. Equat.						
10	3067	June 30	13.4	3.12	-.16	P.	1	2586	May 7	1.87	7.42	+.39	P.
11	3068	" "	16.7	2.62	-.66	P.	2	2587	" "	2.07	7.20	+.17	P.
				3.28	$\pm .40$		3	2619	May 10	2.65	6.67	-.36	S.
106. 38 LYNCIS. Σ 1334. (1878.)							4	2620	" "	2.45	6.84	-.19	S.
1	2541	May 3	26.7	1.49	-.36	P.	5	2748	May 27	1.95	7.34	+.31	U.
2	2542	" "	22.9	1.87	+.02	P.	6	2749	" "	3.22	6.24	-.79	U.
3	2543	" "	24.3	1.73	-.12	U.	7	2803	June 5	2.30	6.98	-.05	P.
4	2544	" "	22.5	1.91	+.06	U.	8	2804	" "	2.12	7.15	+.12	P.
5	2627	May 11	25.1	1.65	-.20	S.	9	2805	" "	2.42	6.87	-.16	P.
6	2628	" "	21.4	2.03	+.18	S.	10	2806	" "	2.02	7.26	+.23	P.
7	2629	" "	25.6	1.60	-.25	P.	11	2860	June 13	2.72	6.61	-.42	S.
8	2630	" "	22.1	1.96	+.11	P.	12	2861	" "	1.72	7.60	+.57	S.
9	2631	May 12	22.4	1.93	+.08	P.	13	2862	" "	1.55	7.84	+.81	U.
10	2632	" "	20.7	2.11	+.26	S.	14	2863	" "	3.02	6.39	-.64	U.
11	2633	" "	23.5	1.81	-.04	P.					7.03	$\pm .37$	
12	2634	" "	20.4	2.15	+.30	S.	110. ζ LEONIS. Σ 18 ^h . 1878. W. Equat.						
				1.85	$\pm .17$		1	2621	May 10	23.7	1.79	-.26	S.
107. 23 ι URSÆ MAJORIS. Σ 1351. (1878.)							2	2622	" "	23.0	1.86	-.19	S.
1	2461	Apr. 18	4.87	5.34	+.05	U.	3	2750	May 27	2.12			U.
2	2462	" "	5.35	5.14	-.15	U.	4	2751	" "	1.90			U.
3	2506	May 1	4.55	5.50	+.21	P.	5	2807	June 5	22.6	1.90	-.15	P.
4	2507	" "	5.07	5.26	-.03	P.	6	2864	June 13	23.5	1.81	-.24	S.
							7	2865	" "	21.6	2.01	-.04	S.
							8	2878	June 14	16.2	2.69	+.64	P.
							9	2879	" "	21.7	2.00	-.05	P.
							10	2880	" "	18.6	2.37	+.32	P.
											2.05	$\pm .24$	

TABLE IV. — LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
111. γ LEONIS. Σ 1424. (1878.)							115. ι LEONIS. Σ 1536. (1878.)						
1	2102	Mar. 10	31.8	1.04	-.15	P.	1	2110	Mar. 10	19.1	2.30	-.37	P.
2	2103	" "	31.5	1.06	-.13	P.	2	2111	" "	19.9	2.21	-.46	P.
3	2346	Mar. 30	27.1	1.45	+.26	S.	3	2267	Mar. 21	15.4	2.80	+.13	P.
4	2347	" "	31.4	1.07	-.12	P.	4	2268	" "	14.9	2.87	+.20	P.
5	2348	" "	34.7	.80	-.39	S.	5	2289	Mar. 22	16.9	2.59	-.08	P.
6	2349	" "	30.1	1.19	.00	P.	6	2290	" "	17.1	2.56	-.11	P.
7	2385	Apr. 2	28.3	1.34	+.15	S.	7	2291	" "	13.9	3.03	+.36	U.
8	2386	" "	29.5	1.24	+.05	S.	8	2292	" "	12.3	3.31	+.64	U.
9	2387	" "	28.0	1.37	+.18	U.	9	2437	Apr. 17	18.3	2.40	-.27	S.
10	2388	" "	27.9	1.38	+.19	U.	10	2438	" "	16.6	2.63	-.04	S.
				1.19	$\pm .16$						2.67	$\pm .27$	
112. 54 LEONIS. Σ 1487. (1878.)							116. 83 LEONIS. Σ 1540. (1878.)						
1	1795	Feb. 16	21.4	2.03	+.13	S.	1	2100	Mar. 9	28.5	1.32	+.29	P.
2	1796	" "	21.7	2.00	+.10	S.	2	2101	" "	31.1	1.10	+.07	P.
3	1797	" "	21.9	1.98	+.08	U.	3	2146	Mar. 15	30.7	1.13	+.10	P.
4	1798	" "	23.6	1.80	-.10	U.	4	2147	" "	32.2	1.01	-.02	P.
5	2106	Mar. 10	20.6	2.12	+.22	P.	5	2148	" "	34.4	.82	-.21	U.
6	2107	" "	23.8	1.88	-.02	P.	6	2149	" "	33.6	.89	-.14	U.
7	2130	Mar. 15	26.0	1.56	-.34	P.	7	2433	Apr. 16	32.3	.99	-.04	S.
8	2131	" "	24.6	1.70	-.20	P.	8	2434	" "	33.6	.89	-.14	S.
9	2132	" "	22.4	1.92	+.02	U.	9	2435	" "	31.8	1.04	+.01	U.
10	2133	" "	21.6	2.01	+.11	U.	10	2436	" "	30.9	1.12	+.09	U.
				1.90	$\pm .13$						1.03	$\pm .11$	
113. ξ URSÆ MAJORIS. Σ 1523. (1878.)							117. τ LEONIS. Σ 191. (1878.)						
1	2108	Mar. 10	39.8	.40	-.06	P.	1	2098	Mar. 9	16.1	2.70	-.02	P.
2	2109	" "	38.2	.52	+.06	P.	2	2099	" "	16.3	2.67	-.05	P.
3	2545	May 3	37.6	.57	+.11	U.	3	2142	Mar. 15	14.2	2.98	+.26	P.
4	2546	" "	38.9	.46	.00	U.	4	2143	" "	15.1	2.84	+.12	P.
5	2547	" "	38.0	.54	+.08	P.	5	2144	" "	17.6	2.49	-.23	U.
6	2548	" "	42.9	.16	-.30	P.	6	2145	" "	20.1	2.18	-.54	U.
7	2775	June 3	44.0	.07	-.39	S.	7	2455	Apr. 18	14.3	2.97	+.25	U.
8	2776	" "	35.7	.72	+.26	S.	8	2456	" "	16.4	2.66	-.06	U.
9	2781	June 4	36.0	.69	+.23	U.	9	2457	" "	12.7	3.23	+.51	S.
10	2782	" "	37.7	.56	+.10	U.	10	2458	" "	17.5	2.51	-.21	S.
11	2783	" "	40.4	.35	-.11	S.					2.72	$\pm .22$	
12	2784	" "	40.6	.44	-.02	S.							
				.46	$\pm .14$								
114. ν URSÆ MAJORIS. Σ 1524. (1878.)							118. 93 LEONIS. Σ 7 ^{II} . (1878.)						
1	2310	Mar. 25	5.27	5.17	-.37	U.	1	2553	May 4	8.67	4.08	-.22	P.
2	2311	" "	6.47	4.72	-.82	U.	2	2554	" "	8.15	4.22	-.08	S.
3	2391	Apr. 8	4.42	5.56	+.02	U.	3	2555	" "	6.25	4.80	+.50	P.
4	2392	" "	5.12	5.24	-.30	U.	4	2556	" "	8.32	4.17	-.13	S.
5	2393	" "	4.95	5.31	-.23	P.	5	2594	May 8	8.62	4.09	-.21	U.
6	2394	" "	4.35	5.59	+.05	P.	6	2595	" "	7.47	4.41	+.11	U.
7	2777	June 3	3.52	6.05	+.51	P.	7	2681	May 19	8.17	4.21	-.09	S.
8	2778	" "	4.27	5.63	+.09	P.	8	2682	" "	7.32	4.46	+.16	P.
9	2779	" "	3.67	5.96	+.42	S.	9	2683	" "	7.47	4.41	+.11	S.
10	2780	" "	3.27	6.21	+.67	S.	10	2684	" "	8.37	4.16	-.14	P.
				5.54	$\pm .35$						4.30	$\pm .17$	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
119. 17 COMÆ BERENICES. Σ 21 ¹ . (1878.) W. Equatorial.							123. 35 COMÆ BER. AB, C. Σ 1687. (1878.)						
1	2881	June 14	23.2	1.84	+.42	P.	1	2689	May 19	6.85	4.60	-.14	P.
2	2882	" "	27.4	1.42	.00	P.	2	2690	" "	6.70	4.65	-.09	S.
3	2883	" "	36.0	.70	-.72	U.	3	2691	" "	5.30	5.16	+.42	P.
4	2884	" "	24.4	1.71	+.29	U.	4	2692	" "	7.70	4.35	-.39	S.
				1.42	$\pm .36$		5	2715	May 25	4.50	5.52	+.78	P.
120. δ CORVI. Σ Un. (1878.)							6	2716	" "	4.77	5.39	+.65	S.
1	2409	Apr. 8	4.25	5.64	+.31	P.	7	2717	" "	6.87	4.59	-.15	P.
2	2410	" "	5.45	5.10	-.23	P.	8	2718	" "	9.02	3.99	-.75	S.
3	2411	" "	5.57	5.05	-.28	U.	9	2956	June 20	7.15	4.50	-.24	U.
4	2412	" "	5.40	5.12	-.21	U.	10	2957	" "	6.58	4.69	-.05	U.
5	2525	May 2	5.07	5.26	-.07	P.					4.74	$\pm .37$	
6	2526	" "	4.67	5.44	+.11	P.	124. 32 H. CAMELOPARDALI. Σ 1694. (1878.)						
7	2527	" "	3.45	6.10	+.77	S.	1	1222	Jan. 1	39.9	.39	-.14	P.
8	2528	" "	5.65	5.02	-.31	S.	2	1223	" "	38.0	.53	.00	P.
9	2596	May 8	4.95	5.31	-.02	U.	3	2537	May 3	43.2	.14	-.39	U.
10	2597	" "	5.02	5.28	-.05	U.	4	2538	" "	37.9	.55	+.02	U.
				5.33	$\pm .24$		5	2539	" "	35.2	.76	+.23	P.
121. 24 COMÆ BERENICES. Σ 1657. (1878.)							6	2540	" "	35.9	.70	+.17	P.
1	2312	Mar. 25	24.8	1.68	+.03	U.	7	2647	May 13	38.8	.47	-.06	S.
2	2313	" "	30.4	1.16	-.49	U.	8	2648	" "	35.7	.72	+.19	S.
3	2685	May 19	26.9	1.47	-.18	P.	9	2649	" "	38.3	.51	-.02	U.
4	2686	" "	24.0	1.76	+.11	S.	10	2650	" "	38.5	.50	-.03	U.
5	2687	" "	24.9	1.67	+.02	P.					.53	$\pm .12$	
6	2688	" "	25.0	1.66	+.01	S.	125. 12 CANUM VENAT. Σ 1692. (1878.)						
7	2700	May 22	22.7	1.89	+.24	P.	1	2112	Mar. 10	15.3	2.81	+.18	P.
8	2701	" "	22.9	1.87	+.22	P.	2	2113	" "	15.6	2.77	+.14	P.
9	2702	" "	24.1	1.75	+.10	U.	3	2134	Mar. 15	17.4	2.52	-.11	P.
10	2703	" "	25.2	1.64	-.01	U.	4	2135	" "	18.6	2.37	-.26	P.
				1.65	$\pm .14$		5	2136	" "	17.9	2.45	-.18	U.
122. γ VIRGINIS. Σ 1670. (1878.)							6	2137	" "	17.4	2.52	-.11	U.
1	2598	May 8	45.4	-.03	.00	U.	7	2549	May 4	14.8	2.89	+.26	P.
2	2599	" "	46.8	-.14	-.11	U.	8	2550	" "	18.0	2.44	-.19	P.
3	2600	" "	43.3	.13	+.16	P.	9	2551	" "	15.4	2.80	+.17	S.
4	2601	" "	48.2	-.24	-.21	P.	10	2552	" "	15.9	2.73	+.10	S.
5	2635	May 12	49.3	-.34	-.31	P.					2.63	$\pm .17$	
6	2636	" "	43.1	.15	+.18	S.	126. 12 CANUM VENAT. Σ 1692. (1878.) Repeated.						
7	2637	" "	43.4	.12	+.15	S.	1	3627	Aug. 29	15.0	2.86	+.23	P.
8	2638	" "	43.2	.14	+.17	P.	2	3628	" "	15.5	2.78	+.15	P.
9	2659	May 17	45.7	-.05	-.02	U.	3	3629	" "	17.5	2.51	-.12	U.
10	2660	" "	45.6	-.04	-.01	U.	4	3630	" "	17.0	2.57	-.06	U.
11	2661	" "	47.0	-.15	-.12	S.	5	3663	Aug. 30	17.7	2.48	-.15	U.
12	2662	" "	43.7	.10	+.13	S.	6	3664	" "	16.3	2.67	+.04	U.
				-.03	$\pm .13$		7	3665	" "	17.4	2.52	-.11	P.
							8	3666	" "	15.6	2.77	+.14	P.
							9	3829	Sept. 14	16.9	2.59	-.04	S.
							10	3830	" "	17.4	2.52	-.11	S.
											2.63	$\pm .12$	

TABLE IV. — LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
127. 12 CANUM VENAT. Σ 1692. (1878.) Aperture 12.7 cms.							θ VIRGINIS A, c. Σ 1724 (continued).						
1	3637	Aug. 29	17.7	2.48	-.11	P.	7	2723	May 25	3.37	6.14	-.16	S.
2	3638	" "	16.6	2.63	+.04	P.	8	2724	" "	3.20	6.26	-.04	S.
3	3639	" "	17.6	2.50	-.09	U.	9	3004	June 25	3.45	6.10	-.20	U.
4	3640	" "	16.7	2.61	+.02	U.	10	3005	" "	3.40	6.13	-.17	U.
5	3667	Aug. 30	15.8	2.74	+.15	P.					6.30	$\pm .13$	
6	3668	" "	18.4	2.39	-.20	P.	131. ζ URSÆ MAJORIS. Σ 1744. (1878.)						
7	3669	" "	15.7	2.76	+.17	U.	1	2114	Mar. 10	24.2	1.74	+.18	P.
8	3670	" "	17.2	2.54	-.05	U.	2	2115	" "	23.7	1.79	+.23	P.
9	3831	Sept. 14	14.2	2.98	+.39	S.	3	2138	Mar. 15	25.5	1.61	+.05	P.
10	3832	" "	15.6	2.27	-.32	S.	4	2139	" "	22.8	1.88	+.32	P.
				2.59	$\pm .15$		5	2140	" "	26.4	1.52	-.04	U.
128. 12 CANUM VENAT. Σ 1692. (1878.) W. Equatorial.							6	2141	" "	27.2	1.44	-.12	U.
1	3734	Sept. 6	21.4	2.03	-.37	U.	7	2502	May 1	27.9	1.38	-.18	S.
2	3735	" "	17.3	2.54	+.14	U.	8	2503	" "	25.4	1.62	+.06	S.
3	3736	" "	18.0	2.44	+.04	P.	9	2504	" "	29.8	1.21	-.35	U.
4	3737	" "	16.1	2.70	+.30	P.	10	2505	" "	27.2	1.45	-.11	U.
5	3757	Sept. 8	17.8	2.46	+.06	P.					1.56	$\pm .16$	
6	3758	" "	19.3	2.28	-.12	S.	132. ζ URSÆ MAJOR. Σ 1744. (1878.) Repeated.						
7	3759	" "	16.9	2.59	+.19	P.	1	3611	Aug. 27	23.6	1.80	+.14	U.
8	3760	" "	18.9	2.33	-.07	S.	2	3612	" "	24.9	1.66	.00	U.
9	3816	Sept. 10	17.5	2.50	+.10	U.	3	3623	Aug. 28	24.2	1.74	+.08	P.
10	3817	" "	20.9	2.09	-.31	U.	4	3624	" "	24.7	1.68	+.02	P.
				2.40	$\pm .17$		5	3625	" "	24.1	1.75	+.09	U.
129. θ VIRGINIS A, B. Σ 1724. (1878.)							6	3626	" "	24.5	1.70	+.04	U.
1	2398	Apr. 8	9.82	3.81	+.04	P.	7	3631	Aug. 29	23.3	1.83	+.17	P.
2	2399	" "	9.35	3.92	+.15	P.	8	3632	" "	28.5	1.33	-.33	P.
3	2400	" "	9.65	3.85	+.08	U.	9	3835	Sept. 14	25.3	1.62	-.04	S.
4	2401	" "	9.80	3.81	+.04	U.	10	3836	" "	27.0	1.47	-.19	S.
5	2402	" "	10.92	3.57	-.20	S.					1.66	$\pm .11$	
6	2403	" "	9.27	3.94	+.17	S.	133. ζ URSÆ MAJORIS. Σ 1744. (1878.) Aperture 12.7 cms.						
7	2673	May 18	10.80	3.60	-.17	S.	1	3633	Aug. 29	26.5	1.51	-.20	P.
8	2674	" "	9.70	3.83	+.06	S.	2	3634	" "	24.7	1.68	-.03	P.
9	2675	" "	9.80	3.81	+.04	P.	3	3635	" "	25.2	1.64	-.07	U.
10	2676	" "	9.37	3.91	+.14	P.	4	3636	" "	24.0	1.75	+.04	U.
11	2719	May 25	10.65	3.63	-.14	P.	5	3671	Aug. 30	25.1	1.65	-.06	P.
12	2720	" "	10.82	3.59	-.18	P.	6	3672	" "	24.3	1.72	+.01	P.
				3.77	$\pm .12$		7	3673	" "	23.3	1.83	+.12	U.
130. θ VIRGINIS A, C. Σ 1724. (1878.)							8	3674	" "	20.8	2.10	+.39	U.
1	2677	May 18	3.10	6.33	+.03	P.	9	3833	Sept. 14	26.0	1.56	-.15	S.
2	2678	" "	2.92	6.45	+.15	P.	10	3834	" "	25.0	1.66	-.05	S.
3	2679	" "	2.67	6.65	+.35	S.					1.71	$\pm .11$	
4	2680	" "	2.97	6.42	+.12	S.							
5	2721	May 25	3.15	6.30	.00	P.							
6	2722	" "	3.22	6.24	-.06	P.							

TABLE IV.—LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
141. α LIBRÆ. (1878.) W. Equat.							δ BOOTIS. Σ 27 ¹ (continued).						
1	2592	May 7	18.2	2.41	+.29	P.	6	2711	May 25	5.05	5.27	+.48	P.
2	2593	" "	17.9	2.46	+.34	P.	7	2712	" "	4.80	5.38	+.59	S.
3	3728	Sept. 6	26.2	1.54	-.58	S.	8	2713	" "	5.92	4.92	+.13	P.
4	3729	" "	26.0	1.56	-.56	S.	9	2714	" "	5.87	4.94	+.15	S.
5	3730	" "	19.5	2.25	+.13	U.	10	2810	June 6	7.05	4.54	-.25	P.
6	3731	" "	21.1	2.07	-.05	U.	11	2811	" "	7.67	4.35	-.44	P.
7	3732	" "	21.2	2.06	-.06	P.					4.79	$\pm .35$	
8	3733	" "	19.9	2.20	+.08	P.	145. 5 SERPENTIS. Σ 1930. (1878.)						
9	3752	Sept. 7	18.7	2.35	+.23	S.	1	2868	June 14	5.82	4.95	+.34	U.
10	3753	Sept. 8	18.2	2.42	+.30	S.	2	2869	" "	7.40	4.43	-.18	U.
11	3754	" "	20.8	2.10	-.02	P.	3	2870	" "	7.22	4.48	-.13	S.
12	3755	" "	21.1	2.07	-.05	S.	4	2871	" "	5.95	4.91	+.30	S.
13	3756	" "	20.8	2.10	-.02	P.	5	3195	July 6	7.30	4.96	+.35	P.
				2.12	$\pm .21$		6	3196	" "	6.13	4.85	+.24	P.
142. ξ BOOTIS. Σ 1888. (1878.)							7	3197	" "	7.52	4.39	-.22	S.
1	2655	May 14	22.9	1.87	-.17	P.	8	3198	" "	8.43	4.15	-.46	S.
2	2656	" "	20.3	2.16	+.12	P.	9	3320	July 19	7.60	4.38	-.23	P.
3	2657	" "	21.8	1.99	-.05	S.	10	3321	" "	6.80	4.62	+.01	P.
4	2658	" "	22.5	1.91	-.13	S.					4.61	$\pm .25$	
5	2725	May 26	22.0	1.97	-.07	P.	146. μ BOOTIS. Σ 28 ¹ . (1878.)						
6	2726	" "	21.4	2.04	.00	S.	1	3336	July 21	17.7	2.48	+.06	P.
7	2727	" "	18.8	2.34	+.30	P.	2	3337	" "	16.9	2.58	+.16	P.
8	2728	" "	21.0	2.08	+.04	S.	3	3355	July 24	19.7	2.23	-.19	S.
9	2866	June 14	18.7	2.35	+.31	U.	4	3356	" "	18.9	2.33	-.09	S.
10	2867	" "	24.3	1.72	-.32	U.	5	3357	" "	18.0	2.44	+.02	P.
				2.04	$\pm .15$		6	3358	" "	18.6	2.36	-.06	P.
143. 44 BOOTIS. Σ 1909. (1878.)							7	3371	July 31	18.4	2.39	-.03	P.
1	2974	June 23	29.2	1.26	+.46	P.	8	3372	" "	19.6	2.24	-.18	P.
2	2975	" "	32.1	1.01	+.21	S.	9	3373	" "	15.6	2.27	-.15	S.
3	2976	" "	33.0	.94	+.14	P.	10	3374	" "	15.5	2.89	+.47	S.
4	2977	" "	33.2	.92	+.12	S.					2.42	$\pm .14$	
5	3162	July 4	37.7	.56	-.24	U.	147. δ SERPENTIS. Σ 1954. (1878.)						
6	3163	" "	37.9	.54	-.26	U.	1	2764	June 1	34.7	.80	-.13	P.
7	3164	" "	35.9	.70	-.10	P.	2	2765	" "	32.5	.98	+.05	P.
8	3165	" "	35.6	.73	-.07	P.	3	2797	June 5	32.6	.97	+.04	S.
9	3201	July 6	34.7	.80	.00	S.	4	2798	" "	38.1	.53	-.40	S.
10	3202	" "	38.1	.53	-.27	S.	5	2799	" "	32.1	1.01	+.08	U.
				.80	$\pm .19$		6	2800	" "	34.6	.80	-.13	U.
144. δ BOOTIS. Σ 27 ¹ . (1878.)							7	2821	June 7	31.7	1.05	+.12	P.
1	2404	Apr. 8	4.75	5.40	+.61	S.	8	2822	" "	31.3	1.08	+.15	P.
2	2405	" "	6.97	4.56	-.23	P.	9	2823	" "	30.1	1.19	+.26	S.
3	2406	" "	6.77	4.63	-.16	P.	10	2824	" "	33.7	.88	-.05	S.
4	2407	" "	6.82	4.61	-.18	U.					.93	$\pm .14$	
5	2408	" "	8.45	4.14	-.65	U.							

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
148. ζ CORONÆ. Σ 1965. (1878.)							152. β SCORPII. Σ Un. (1878.)						
1	2790	June 5	34.1	.84	-.05	P.	1	2835	June 9	21.5	2.02	-.14	P.
2	2791	" "	34.9	.78	-.11	P.	2	2836	" "	19.8	2.22	+.06	P.
3	2793	" "	32.3	1.00	+.11	U.	3	2837	" "	21.7	2.00	-.16	S.
4	2795	" "	29.0	1.28	+.39	U.	4	2838	" "	20.1	2.19	+.03	S.
5	2922	June 18	34.5	1.36	+.47	S.	5	2963	June 20	18.8	2.34	+.18	S.
6	2923	" "	33.5	.90	+.01	S.	6	2964	" "	21.3	2.04	-.12	S.
7	2924	" "	35.3	.75	-.14	U.	7	2965	" "	20.8	2.10	-.06	U.
8	2925	" "	35.8	.71	-.18	U.	8	2966	" "	19.9	2.21	+.05	U.
9	2970	June 23	36.1	.68	-.21	P.	9	3061	June 30	19.6	2.24	+.08	P.
10	2971	" "	33.5	.90	+.01	P.	10	3062	" "	19.7	2.23	+.07	P.
11	2972	" "	35.7	.71	-.18	S.					2.16	$\pm .09$	
12	2973	" "	34.8	.79	-.10	S.							
				.89	$\pm .16$		153. κ HERCULIS. Σ 2010. (1878.)						
149. α SERPENTIS. (1878.)							1	2766	June 1	30.2	1.17	-.03	P.
1	3073	June 30	.67	9.64	-.58	S.	2	2767	" "	31.6	1.06	-.14	P.
2	3074	" "	.35	11.07	+.85	S.	3	2894	June 15	30.7	1.13	-.07	P.
3	3075	" "	.47	10.41	+.19	P.	4	2895	" "	32.2	1.00	-.20	S.
4	3076	" "	.67	9.64	-.58	P.	5	2896	" "	29.2	1.26	+.06	P.
5	3110	July 1	.50	10.30	+.08	U.	6	2897	" "	27.7	1.40	+.20	S.
6	3111	" "	.65	9.72	-.50	U.	7	2950	June 20	27.5	1.42	+.22	U.
7	3112	" "	.55	10.09	-.13	S.	8	2951	" "	27.8	1.39	+.19	U.
8	3113	" "	.47	10.41	+.19	S.	9	2954	" "	31.2	1.09	-.11	S.
9	3318	July 19	.30	11.40	+1.18	P.	10	2955	" "	30.7	1.13	-.07	S.
10	3319	" "	.72	9.49	-.73	P.					1.20	$\pm .13$	
				10.22	$\pm .50$		154. ν SCORPII A, BC. (1878.)						
150. β SERPENTIS. Σ 1970. (1878.)							1	2831	June 9	21.7	2.00	-.24	P.
1	2729	May 26	3.00	6.40	+.19	P.	2	2832	" "	18.0	2.44	+.20	S.
2	2730	" "	3.10	6.33	+.12	P.	3	2833	" "	18.7	2.35	+.11	P.
3	2731	" "	2.97	6.42	+.21	S.	4	2834	" "	18.9	2.33	+.09	S.
4	2732	" "	4.35	5.59	-.62	S.	5	2989	June 24	20.7	2.12	-.12	U.
5	2762	June 1	3.05	6.37	+.16	P.	6	2990	" "	21.3	2.04	-.20	U.
6	2763	" "	3.20	6.26	+.05	P.	7	3000	June 25	19.6	2.24	.00	P.
7	2872	June 14	2.55	6.75	+.54	S.	8	3001	" "	19.4	2.27	+.03	P.
8	2873	" "	3.65	5.98	-.23	S.	9	3002	" "	19.5	2.25	+.01	U.
9	3006	June 25	3.52	6.05	-.16	U.	10	3003	" "	18.6	2.36	+.12	U.
10	3007	" "	3.72	5.93	-.28	U.					2.24	$\pm .11$	
				6.21	$\pm .26$		155. σ CORONÆ A, B. Σ 2032. (1878.)						
151. η LUPI. (1878.)							1	3386	Aug. 3	35.0	.77	-.08	P.
1	3008	June 25	7.40	4.43	+.25	U.	2	3387	" "	36.8	.63	-.22	P.
2	3009	" "	7.55	4.39	+.21	U.	3	3388	" "	34.3	.83	-.02	S.
3	3010	" "	7.85	4.30	+.12	S.	4	3389	" "	36.2	.84	-.01	S.
4	3011	" "	11.85	3.39	-.79	S.	5	3405	Aug. 5	30.2	1.17	+.32	P.
5	3239	July 10	6.88	4.59	+.41	S.	6	3406	" "	30.4	1.16	+.31	P.
6	3240	" "	8.40	4.16	-.02	S.	7	3407	" "	35.4	.74	-.11	P.
7	3247	July 13	8.05	4.24	+.06	P.	8	3408	" "	35.7	.72	-.13	S.
8	3248	" "	8.85	4.04	-.14	P.	9	3417	Aug. 7	34.2	.84	-.01	S.
9	3313	July 19	7.40	4.43	+.25	P.	10	3418	" "	34.8	.79	-.06	S.
10	3314	" "	9.83	3.80	-.38	P.	11	3419	" "	37.1	.60	-.25	P.
				4.18	$\pm .26$		12	3420	" "	31.4	1.07	+.22	P.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
σ CORONÆ A, B. Σ 2032 (continued).							159. η DRACONIS. (1878.)						
13	3908	Sept. 18	30.8	1.13	+ .28	P.	1	3421	Aug. 7	4.83	5.36	— .50	P.
14	3909	" "	36.2	.68	— .17	P.	2	3422	" "	3.72	5.93	+ .07	P.
15	3910	" "	32.8	.95	+ .10	U.	3	3423	" "	3.15	6.30	+ .44	S.
16	3911	" "	35.8	.71	— .14	U.	4	3424	" "	3.65	5.97	+ .11	S.
				.85	$\pm$.15		5	3600	Aug. 26	4.30	5.62	— .24	U.
156. σ CORONÆ A, C. Σ 2032. (1878.)							6	3601	" "	4.00	5.78	— .08	U.
1	3390	Aug. 3	3.75	5.91	+ .84	P.	7	3619	Aug. 27	3.67	5.96	+ .10	P.
2	3391	" "	6.33	4.78	— .29	P.	8	3620	" "	8.47	[4.14]		P.
3	3392	" "	8.72	4.07	— 1.00	S.	9	3675	Aug. 30	3.97	5.79	— .07	P.
4	3393	" "	3.73	5.93	+ .86	S.	10	3676	" "	4.70	5.42	— .44	P.
5	3402	Aug. 5	5.05	5.27	+ .20	P.	11	3677	" "	3.30	6.20	+ .34	U.
6	3403	" "	4.85	5.35	+ .28	P.	12	3678	" "	3.38	6.14	+ .28	U.
7	3404	" "	5.10	5.25	+ .18	S.					5.86	$\pm$.24	
8	3413	Aug. 7	8.75	4.06	— 1.01	S.	160. 17 DRACONIS A, B. Σ 301. (1878.)						
9	3414	" "	5.15	5.22	+ .15	S.	1	2918	June 16	44.7	+ .02	+ .13	S.
10	3415	" "	4.30	5.62	+ .55	P.	2	2919	" "	46.0	— .07	+ .04	P.
11	3416	" "	5.85	4.95	— .12	P.	3	2920	" "	42.9	+ .16	+ .27	S.
12	3912	Sept. 18	7.05	4.54	— .53	U.	4	2921	" "	44.8	+ .02	+ .13	P.
13	3913	" "	6.65	4.66	— .41	U.	5	3120	July 2	47.0	— .15	— .04	U.
14	3914	" "	4.95	5.31	+ .24	P.	6	3121	" "	52.7	— .59	— .48	U.
15	3915	" "	5.38	5.13	+ .06	P.	7	3126	" "	43.9	+ .08	+ .19	S.
				5.07	$\pm$.43		8	3127	" "	49.8	— .37	— .26	S.
157. σ SCORPII. (1878.)							9	3311	July 19	46.4	— .10	+ .01	P.
1	2902	June 15	4.37	5.58	+ .14	P.	10	3312	" "	46.2	— .09	+ .02	P.
2	2903	" "	4.30	5.62	+ .18	P.					— .11	$\pm$.16	
3	2904	" "	3.70	5.95	+ .51	S.	161. 17 DRACONIS A, C. Σ 2078. (1878.)						
4	2905	" "	6.15	4.84	— .60	S.	1	2914	June 16	33.4	.90	— .16	P.
5	3077	June 30	5.02	5.27	— .17	P.	2	2915	" "	31.4	1.07	+ .01	S.
6	3078	" "	4.42	5.56	+ .12	P.	3	2916	" "	34.4	.82	— .24	P.
7	3079	" "	5.10	5.24	— .20	S.	4	2917	" "	36.3	.67	— .39	S.
8	3080	" "	5.45	5.10	— .34	S.	5	3122	July 2	27.9	1.38	+ .32	U.
9	3108	July 1	4.57	5.48	+ .04	U.	6	3123	" "	28.2	1.35	+ .29	U.
10	3109	" "	4.05	5.75	+ .31	U.	7	2124	" "	32.2	1.01	— .05	S.
				5.44	$\pm$.26		8	3125	" "	30.4	1.16	+ .10	S.
158. ν^2 CORONÆ. (1878.)							9	3309	July 19	33.4	.90	— .16	P.
1	3367	July 24	6.42	4.74	— .45	P.	10	3310	" "	28.9	1.29	+ .23	P.
2	3368	" "	5.35	5.14	— .05	P.					1.06	$\pm$.20	
3	3369	" "	6.87	4.59	— .60	S.	162. 43 HERCULIS. Σ Un. (1878.)						
4	3370	" "	7.15	4.51	— .68	S.	1	2898	June 15	10.70	3.62	— .11	P.
5	3379	Aug. 2	4.43	5.55	+ .36	P.	2	2899	" "	9.27	3.93	+ .20	S.
6	3380	" "	5.42	5.11	— .08	P.	3	2900	" "	10.45	3.67	— .06	P.
7	3381	" "	4.70	5.43	+ .24	S.	4	2901	" "	9.72	3.83	+ .10	S.
8	3382	" "	4.35	5.59	+ .40	S.	5	2958	June 20	14.25	2.97	— .76	S.
9	3394	Aug. 3	4.45	5.54	+ .35	P.	6	2959	" "	8.23	4.19	+ .46	S.
10	3395	" "	4.20	5.67	+ .48	P.	7	2961	" "	11.37	3.48	— .25	U.
				5.19	$\pm$.37		8	2962	" "	10.22	3.72	— .01	U.
							9	3199	July 6	8.87	4.03	+ .30	P.
							10	3200	" "	9.60	3.86	+ .13	P.
											3.73	$\pm$.24	

TABLE IV. — LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
171. ν DRACONIS. Σ 351. (1878.)							67 OPHIUCHI. Σ Un. (continued).						
1	2665	May 17	48.4	-.26	-.22	S	10	3043	June 29	8.60	4.10	-.13	P.
2	2666	" "	48.4	-.26	-.22	S.	11	3044	" "	7.72	4.34	+.11	S.
3	2741	May 26	44.0	.07	+.11	P.	12	3045	" "	6.32	4.77	+.54	S.
4	2742	" "	45.9	-.07	-.03	S.	13	3102	July 1	10.72	3.62	-.61	U.
5	2743	" "	43.9	.08	+.12	S.	14	3103	" "	7.20	4.49	+.26	U.
6	2744	" "	45.5	-.04	.00	P.					4.23	$\pm .28$	
7	2754	May 29	46.0	-.07	-.03	S.	175. 95 HERCULIS. Σ 2264. (1878.)						
8	2755	" "	45.8	-.06	-.02	S.	1	3098	July 1	45.9	-.07	-.12	U.
9	2756	" "	41.3	.28	+.32	U.	2	3099	" "	42.8	.16	+.11	U.
10	2757	" "	43.9	.08	+.12	U.	3	3100	" "	46.8	-.13	-.18	P.
11	2812	June 6	45.3	-.02	+.02	P.	4	3101	" "	44.2	.06	+.01	P.
12	2813	" "	47.9	-.22	-.18	P.	5	3207	July 7	44.6	.03	-.02	P.
				-.04	$\pm .12$		6	3208	" "	44.3	.05	.00	P.
172. μ HERCULIS. Σ 2220. (1878.)							7	3293	July 16	43.4	.12	+.07	P.
1	2663	May 17	4.25	5.64	-.57	P.	8	3294	" "	47.7	-.20	-.25	P.
2	2664	" "	5.05	5.26	-.95	P.	9	3295	" "	40.2	.37	+.32	S.
3	2737	May 26	3.32	6.18	-.03	P.	10	3296	" "	43.2	.14	+.09	S.
4	2738	" "	2.77	6.58	+.37	P.					.05	$\pm .12$	
5	2739	" "	2.87	6.50	+.29	S.	176. 70 P. OPHIUCHI. Σ 2272. (1878.)						
6	2740	" "	3.40	6.13	-.08	S.	1	2938	June 19	27.9	1.38	-.32	P.
7	3030	June 28	2.72	6.61	+.40	U.	2	2939	" "	20.1	2.18	+.48	P.
8	3031	" "	2.72	6.61	+.40	U.	3	2940	" "	23.9	1.77	+.07	S.
9	3032	" "	3.00	6.40	+.19	S.	4	3013	June 26	21.6	2.01	+.31	U.
10	3033	" "	3.23	6.24	+.03	S.	5	3014	" "	25.7	1.59	-.11	U.
				6.21	$\pm .33$		6	3015	" "	21.2	2.05	+.35	P.
173. ψ DRACONIS. Σ 2241. (1878.)							7	3016	" "	28.0	1.37	-.33	P.
1	2651	May 13	32.5	.98	-.20	S.	8	3038	June 29	28.8	1.30	-.40	S.
2	2652	" "	30.5	1.15	-.03	S.	9	3039	" "	24.3	1.73	+.03	S.
3	2653	" "	32.8	.95	-.23	U.	10	3040	" "	23.2	1.84	+.14	P.
4	2654	" "	29.1	1.27	+.09	U.	11	3041	" "	27.2	1.44	-.26	P.
5	3243	July 13	30.8	1.12	-.06	S.					1.70	$\pm .25$	
6	3244	" "	28.3	1.34	+.16	S.	177. μ SAGITTARI A, B. (1878.)						
7	3245	" "	32.8	.96	-.22	P.	1	3087	June 30	3.85	5.86	+.16	P.
8	3246	" "	27.2	1.45	+.27	P.	2	3088	" "	4.10	5.72	+.02	P.
9	3307	July 19	28.3	1.34	+.16	P.	3	3089	" "	4.70	5.43	-.27	S.
10	3308	" "	29.8	1.21	+.03	P.	4	3090	" "	3.67	5.96	+.26	S.
				1.18	$\pm .14$		5	3141	July 3	4.67	5.43	-.27	P.
174. 67 OPHIUCHI. Σ Un. (1878.)							6	3142	" "	3.75	5.92	+.22	P.
1	2941	June 19	9.47	3.88	-.35	P.	7	3147	" "	5.27	5.17	-.53	U.
2	2942	" "	6.75	4.64	+.41	P.	8	3148	" "	3.87	5.85	+.15	U.
3	2943	" "	8.20	4.20	-.03	S.	9	3257	July 13	3.75	5.91	+.21	S.
4	2944	" "	10.65	3.63	-.60	S.	10	3258	" "	3.97	5.79	+.09	S.
5	3017	June 26	6.78	4.63	+.40	P.					5.70	$\pm .22$	
6	3018	" "	8.42	4.15	-.08	P.							
7	3019	" "	7.62	4.37	+.14	U.							
8	3020	" "	8.67	4.09	-.14	U.							
9	3042	June 29	7.73	4.33	+.10	P.							

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
178. μ SAGITTARI A, C. (1878.)							182. 39 DRACONIS A, C. Σ 2323. (1877.)						
1	3083	June 30	5.62	5.03	-.32	S.	1	747	Dec. 3	14.2	2.98	+.32	P.
2	3084	" "	5.10	5.24	-.11	S.	2	748	" "	16.7	2.61	-.05	S.
3	3085	" "	5.45	5.10	-.25	P.	3	934	Dec. 16	14.0	3.01	+.35	P.
4	3086	" "	4.80	5.38	+.03	P.	4	935	" "	15.8	2.74	+.08	P.
5	3143	July 3	4.00	5.78	+.43	P.	5	936	" "	17.1	2.56	-.10	S.
6	3144	" "	4.95	5.31	-.04	P.	6	937	" "	20.4	2.15	-.51	S.
7	3145	" "	4.62	5.45	+.10	U.	7	977	Dec. 18	16.1	2.70	+.04	S.
8	3146	" "	4.72	5.41	+.06	U.	8	978	" "	17.9	2.45	-.21	P.
9	3255	July 13	4.63	5.46	+.11	S.	9	979	" "	16.5	2.64	-.02	S.
10	3256	" "	4.80	5.38	+.03	S.	10	980	" "	15.8	2.74	+.08	P.
				5.35	$\pm .15$						2.66	$\pm .18$	
179. η SERPENTIS. Σ 8 ^{II} . (1878.)							183. 39 DRACONIS A, C. Σ 2323. (1878.) Repeated.						
1	3025	June 26	1.42	8.02	+.56	P.	1	3132	July 3	13.7	3.56	+.97	S.
2	3026	" "	1.92	7.36	-.10	P.	2	3133	" "	19.6	2.24	-.35	S.
3	3052	June 29	1.40	8.06	+.60	P.	3	3138	" "	14.3	2.97	+.38	U.
4	3053	" "	1.65	7.70	+.24	P.	4	3139	" "	16.7	2.62	+.03	U.
5	3054	" "	2.27	7.00	-.46	S.	5	3330	July 21	15.4	2.80	+.21	P.
6	3055	" "	1.80	7.52	+.06	S.	6	3331	" "	18.2	2.41	-.18	P.
7	3324	July 19	1.73	7.60	+.14	P.	7	3343	July 23	19.7	2.23	-.36	S.
8	3325	" "	2.00	7.29	-.17	P.	8	3344	" "	19.9	2.21	-.38	S.
9	3326	" "	2.42	6.86	-.60	S.	9	3345	" "	19.3	2.28	-.31	P.
10	3327	" "	2.13	7.15	-.31	S.	10	3346	" "	17.0	2.57	-.02	P.
				7.46	$\pm .32$						2.59	$\pm .32$	
180. 21 SAGITTARI. (1878.)							184. 39 DRACONIS A, B. Σ 2323. (1878.)						
1	3231	July 8	19.1	2.30	-.22	U.	1	3134	July 3	15.2	2.83	-.09	S.
2	3232	" "	17.0	2.58	+.06	U.	2	3135	" "	17.5	2.56	-.36	S.
3	4003	Sept. 23	17.7	2.48	-.04	P.	3	3136	" "	12.4	3.29	+.37	U.
4	4004	" "	11.3	3.49	+.97	P.	4	3137	" "	13.4	3.12	+.20	U.
5	4075	Sept. 28	27.8	1.39	-1.13	P.	5	3328	July 20	14.2	2.98	+.06	P.
6	4076	" "	16.5	2.64	+.12	P.	6	3329	" "	13.7	3.07	+.15	P.
7	4077	" "	14.6	2.92	+.40	S.	7	3347	July 23	14.9	2.87	-.05	S.
8	4078	" "	14.5	2.94	+.42	S.	8	3348	" "	16.5	2.64	-.28	S.
9	4079	" "	23.5	1.81	-.71	P.	9	3349	" "	13.6	3.08	+.16	P.
10	4098	Sept. 29	19.3	2.28	-.24	P.	10	3350	" "	15.4	2.80	-.12	P.
11	4099	" "	15.1	2.84	+.32	P.					2.92	$\pm .18$	
				2.52	$\pm .42$								
181. 59 SERPENTIS. Σ 2316. (1878.)							185. α LYRÆ. Σ 9 ^{II} . (1877.)						
1	3021	June 26	19.8	2.22	+.12	U.	1	1144	Dec. 27	.70	9.56	-.41	P.
2	3022	" "	21.5	2.02	-.08	U.	2	1145	" "	.60	9.90	-.07	S.
3	3023	" "	21.5	2.03	-.07	P.	3	1146	" "	.50	10.29	+.32	P.
4	3024	" "	20.8	2.10	.00	P.	4	1147	" "	.55	10.10	+.13	S.
5	3046	June 29	20.2	2.17	+.07	S.	5	1180	Dec. 28	.60	9.90	-.07	P.
6	3047	" "	21.5	2.02	-.08	S.	6	1181	" "	.72	9.49	-.48	S.
7	3048	" "	21.3	2.05	-.05	P.	7	1182	" "	.50	10.29	+.32	P.
8	3049	" "	23.0	1.86	-.24	P.	8	1183	" "	.50	10.29	+.32	S.
9	3305	July 17	20.1	2.18	+.08	S.	9	1209	Dec. 29	.67	9.64	-.33	P.
10	3306	" "	18.5	2.38	+.28	S.	10	1210	" "	.57	9.99	+.02	S.
				2.10	$\pm .11$		11	1211	" "	.57	9.99	+.02	P.
							12	1212	" "	.52	10.19	+.22	S.
											9.97	$\pm .23$	

TABLE IV. — LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
186. 110 HERCULIS. (1878.)							189. 5 LYRÆ. Σ 2383 (continued).						
1	3340	July 22	1.15	8.49	-.42	P.	10	1009	Dec. 22	42.8	.17	-.06	P.
2	3341	" "	.65	9.72	+.81	P.	11	1010	" "	42.3	.20	-.03	P.
3	3351	July 23	1.25	8.31	-.60	P.	12	1057	Dec. 24	42.5	.19	-.04	S.
4	3352	" "	.83	9.21	+.30	P.					.23	$\pm .08$	
5	3353	" "	1.02	8.74	-.17	S.	190. ζ LYRÆ. Σ 381. (1877.)						
6	3354	" "	.88	9.08	+.17	S.	1	744	Dec. 3	29.8	1.21	-.17	P.
7	3398	Aug. 3	.98	8.84	-.07	P.	2	745	" "	29.1	1.27	-.11	P.
8	3399	" "	1.08	8.64	-.27	P.	3	746	" "	29.2	1.26	-.12	S.
9	3400	" "	.80	9.27	+.36	S.	4	839	Dec. 9	31.8	1.04	-.32	P.
10	3401	" "	.98	8.85	-.06	S.	5	840	" "	27.7	1.40	+.02	P.
				8.91	$\pm .32$		6	848	Dec. 13	25.1	1.65	+.27	P.
187. ϵ , 5 LYRÆ. Σ 371. (1878.) W. Equat.							7	849	" "	27.3	1.43	+.05	P.
1	2588	May 7	48.0	-.23	-.18	P.	8	850	" "	29.3	1.25	-.13	U.
2	2589	" "	46.1	-.08	-.03	P.	9	851	" "	27.7	1.40	+.02	U.
3	4049	Sept. 25	47.7	-.21	-.16	U.	10	926	Dec. 16	27.2	1.44	+.06	P.
4	4050	" "	46.1	-.08	-.03	U.	11	927	" "	28.0	1.35	-.03	P.
5	4062	Sept. 27	38.8	+.47	+.52	P.	12	928	" "	26.0	1.56	+.18	S.
6	4063	" "	36.9	+.62	+.67	P.	13	929	" "	25.0	1.66	+.28	S.
7	4064	" "	42.0	+.23	+.28	P.					1.38	$\pm .13$	
8	4069	" "	46.6	-.12	-.07	S.	191. ζ LYRÆ. Σ 381. (1878.) W. Equat.						
9	4070	" "	46.8	-.13	-.08	S.	1	2590	May 7	26.5	1.51	+.05	P.
10	4088	Sept. 28	52.4	-.57	-.52	S.	2	2591	" "	27.6	1.41	-.05	P.
11	4089	" "	50.6	-.43	-.38	S.					1.46	$\pm .05$	
				-.05	$\pm .27$		192. β LYRÆ. Σ 391. (1878.) First Minimum.						
188. ϵ LYRÆ. Σ 2382. (1877.)							1	3235	July 9	12.07	3.35	+.09	S.
1	727	Dec. 2	31.8	1.04	+.08	P.	2	3236	" "	12.35	3.29	+.03	S.
2	728	" "	33.5	.89	-.07	P.	3	3338	July 22	11.90	3.38	+.12	P.
3	729	" "	32.0	1.02	+.06	S.	4	3339	" "	12.85	3.21	-.05	P.
4	730	" "	34.1	.85	-.11	S.	5	3683	Aug. 30	12.35	3.30	+.04	P.
5	847	Dec. 13	30.6	1.14	+.18	P.	6	3684	" "	12.35	3.29	+.03	P.
6	942	Dec. 16	29.9	1.20	+.24	P.	7	3685	" "	14.03	3.01	-.25	U.
7	943	" "	31.4	1.07	+.11	P.	8	3686	" "	12.30	3.31	+.05	U.
8	944	" "	33.0	.94	-.02	S.	9	4038	Sept. 25	12.05	3.35	+.09	S.
9	945	" "	35.9	.70	-.26	S.	10	4039	" "	13.53	3.09	-.17	S.
10	973	Dec. 18	32.9	.94	-.02	P.					3.26	$\pm .09$	
11	974	" "	35.3	.75	-.21	P.	193. β LYRÆ. Σ 391. (1878.) First Maximum.						
				.96	$\pm .12$		1	3259	July 13	9.50	3.88	-.01	P.
189. 5 LYRÆ. Σ 2383. (1877.)							2	3260	" "	9.70	3.83	-.06	P.
1	731	Dec. 2	52.8	[-.60]	+.09	S.	3	3261	" "	7.88	4.33	+.44	S.
2	946	Dec. 16	40.8	.32	+.22	P.	4	3262	" "	10.35	3.69	-.20	S.
3	947	" "	39.1	.45	-.21	P.	5	3409	Aug. 7	8.95	4.02	+.13	P.
4	975	Dec. 18	44.7	.02	-.21	P.	6	3410	" "	9.47	3.88	-.01	P.
5	976	" "	40.4	.35	+.12	S.	7	3411	" "	11.17	3.52	-.37	S.
6	989	Dec. 20	41.8	.24	+.01	S.							
7	990	" "	42.1	.22	-.01	P.							
8	991	" "	42.6	.18	-.05	S.							
9	992	" "	42.3	.20	-.03	P.							

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
β Lyræ. Σ 39 ¹ (continued).							197. θ Serpentis. Σ 2417. (1878.)						
8	3412	Aug. 7	9.83	3.81	-.08	S.	1	3166	July 5	38.5	.50	-.37	P.
9	3726	Sept. 2	9.02	3.99	+.10	U.	2	3167	" "	37.0	.61	-.26	P.
10	3727	" "	9.32	3.92	+.03	U.	3	3168	" "	39.7	.41	-.46	U.
				3.89	$\pm$.14		4	3169	" "	40.5	.34	-.53	U.
194. β Lyræ. Σ 39 ¹ . (1878.) Second Minimum.							5	3205	July 7	38.2	.52	-.35	P.
1	3297	July 16	10.08	3.75	+.33	P.	6	3206	" "	37.7	.56	-.31	P.
2	3298	" "	14.05	3.00	-.42	P.	7	3263	July 15	27.6	1.41	+.54	S.
3	3299	" "	12.45	3.28	-.14	S.	8	3264	" "	25.0	1.56	+.69	S.
4	3300	" "	9.90	3.79	+.37	S.	9	3265	" "	24.7	1.69	+.82	P.
5	3919	Sept. 18	11.35	3.49	+.07	U.	10	3266	" "	31.2	1.09	+.22	P.
6	3920	" "	11.55	3.44	+.02	U.					.87	$\pm$.46	
7	3921	" "	10.83	3.59	+.17	S.	198. η Lyræ. Σ 2487. (1877.)						
8	3922	" "	13.20	3.15	-.27	S.	1	793	Dec. 7	11.22	3.51	-.29	S.
9	3934	Sept. 19	11.85	3.39	-.03	P.	2	794	" "	10.12	3.74	-.06	U.
10	3935	" "	12.22	3.32	-.10	P.	3	795	" "	10.97	3.56	-.24	U.
				3.42	$\pm$.19		4	796	" "	12.15	3.33	-.47	S.
195. β Lyræ. Σ 39 ¹ . (1878.) Second Maximum.							5	874	Dec. 14	9.30	3.93	+.13	P.
1	3191	July 6	8.55	4.11	+.22	P.	6	875	" "	9.70	3.84	+.04	S.
2	3192	" "	8.33	4.17	+.28	S.	7	876	" "	10.28	3.71	-.09	P.
3	3193	" "	9.40	3.90	+.01	P.	8	877	" "	9.08	3.98	+.18	S.
4	3194	" "	9.30	3.93	+.04	S.	9	930	Dec. 16	8.57	4.11	+.31	P.
5	3539	Aug. 14	10.65	3.63	-.26	P.	10	931	" "	8.87	4.03	+.23	P.
6	3540	" "	9.07	3.98	+.09	P.	11	932	" "	9.67	3.84	+.04	S.
7	3541	" "	10.45	3.67	-.22	S.	12	933	" "	8.77	4.05	+.25	S.
8	3542	" "	10.17	3.71	-.18	S.					3.80	$\pm$.19	
9	3621	Aug. 27	9.65	3.85	-.04	U.	199. η Lyræ. Σ 2487. (1878.) Repeated.						
10	3622	" "	9.10	3.97	+.08	U.	1	3687	Aug. 30	8.67	4.08	+.01	P.
				3.89	$\pm$.14		2	3688	" "	8.35	4.20	+.13	P.
196. α Draconis. Σ 2420. (1877.)							3	3689	" "	9.23	3.95	-.12	U.
1	749	Dec. 3	12.8	3.22	-.09	P.	4	3690	" "	8.15	4.22	+.15	U.
2	750	" "	15.5	2.88	-.43	S.	5	3692	Sept. 1	7.55	4.39	+.32	P.
3	751	" "	11.4	3.48	+.17	U.	6	3693	" "	7.50	4.40	+.33	P.
4	878	Dec. 14	15.1	2.85	-.46	S.	7	3868	Sept. 16	10.77	3.60	-.47	S.
5	879	" "	14.3	2.97	-.34	S.	8	3869	" "	8.70	4.08	+.01	S.
6	880	" "	10.7	3.62	+.31	P.	9	3870	" "	9.85	3.80	-.27	U.
7	881	" "	9.9	3.79	+.48	P.	10	3871	" "	8.98	4.00	-.07	U.
8	882	" "	12.9	3.20	-.11	C.					4.07	$\pm$.19	
9	938	Dec. 16	10.8	3.60	+.29	P.	200. η Lyræ. Σ 2487. (1878.) Aperture 12.7 cms.						
10	939	" "	10.2	3.72	+.41	P.	1	3698	Sept. 1	8.53	4.12	+.11	P.
11	940	" "	12.3	3.31	.00	S.	2	3699	" "	8.45	4.14	+.13	P.
12	941	" "	13.3	3.13	-.18	S.	3	3851	Sept. 15	6.80	4.62	+.61	P.
				3.31	$\pm$.27		4	3852	" "	9.67	3.84	-.17	P.
							5	3853	" "	12.05	3.35	-.66	S.
							6	3854	" "	8.75	4.06	+.05	S.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
η Lyræ. Σ 2487 (continued).							204. β Cygni. Σ 43 ^r . (1878.) Aperture 12.7 cms.						
7	3872	Sept. 16	8.30	4.18	+ .17	U.	1	3696	Sept. 1	21.9	1.98	— .11	P.
8	3873	" "	9.33	3.92	— .09	U.	2	3697	" "	21.5	2.02	— .07	P.
9	3874	" "	10.00	3.77	— .24	S.	3	3722	Sept. 2	19.1	2.31	+ .22	S.
10	3875	" "	8.60	4.10	+ .09	S.	4	3723	" "	22.3	1.93	— .16	S.
				4.01	$\pm$.23		5	3724	" "	20.6	2.12	+ .03	U.
201. η Lyræ. Σ 2487. (1878.) W. Equat.							6	3725	" "	21.5	2.02	— .07	U.
1	4026	Sept. 23	11.60	3.44	— .94	P.	7	3849	Sept. 15	21.5	2.03	— .06	P.
2	4027	" "	8.25	4.19	— .19	P.	8	3850	" "	19.4	2.24	+ .15	P.
3	4071	Sept. 27	8.27	4.18	— .20	U.	9	3855	" "	20.2	2.17	+ .08	S.
4	4072	" "	9.43	3.90	— .48	U.	10	3856	" "	21.1	2.07	— .02	S.
5	4092	Sept. 28	8.20	4.20	— .18	P.					2.09	$\pm$.10	
6	4093	" "	9.10	3.98	— .40	P.	205. β Cygni. Σ 43 ^r . (1878.) W. Equat.						
7	4130	Sept. 30	7.25	4.47	+ .09	S.	1	3821	Sept. 12	18.2	2.41	+ .23	U.
8	4131	" "	4.72	5.41	+ 1.03	S.	2	3822	" "	21.4	2.04	— .14	U.
9	4143	Oct. 1	4.97	5.30	+ .92	S.	3	3974	Sept. 20	18.9	2.33	+ .15	P.
10	4144	" "	6.40	4.75	+ .37	S.	4	3975	" "	20.2	2.17	— .01	P.
				4.38	$\pm$.48		5	4065	Sept. 27	20.0	2.19	+ .01	P.
202. β Cygni. Σ 43 ^r . (1877.)							6	4066	" "	21.9	1.98	— .20	P.
1	806	Dec. 8	20.7	2.11	— .03	S.	7	4067	" "	19.6	2.24	+ .06	S.
2	807	" "	22.7	1.89	— .25	P.	8	4068	" "	17.6	2.49	+ .31	S.
3	808	" "	21.8	1.99	— .15	S.	9	4090	Sept. 28	21.8	1.98	— .20	S.
4	809	" "	19.0	2.31	+ .17	U.	10	4091	" "	21.7	2.00	— .18	S.
5	810	" "	20.3	2.16	+ .02	U.					2.18	$\pm$.15	
6	811	" "	23.7	1.79	— .35	P.	206. β Cygni. Σ 43 ^r . (1877.) Through red glass.						
7	981	Dec. 18	20.1	2.18	+ .04	P.	1	987	Dec. 18	16.7	2.62	+ .08	P.
8	982	" "	18.9	2.33	+ .19	S.	2	988	" "	17.9	2.45	— .09	S.
9	983	" "	17.7	2.48	+ .34	P.					2.54	$\pm$.08	
10	984	" "	20.1	2.18	+ .04	S.	207. β Cygni. Σ 43 ^r . (1877.) Through blue glass.						
11	1007	Dec. 22	20.2	2.17	+ .03	P.	1	985	Dec. 18	21.6	2.01	+ .07	P.
12	1008	" "	20.6	2.12	— .02	P.	2	986	" "	23.8	1.88	— .06	S.
				2.14	$\pm$.14						1.94	$\pm$.06	
203. β Cygni. Σ 43 ^r . (1878.) Repeated.							208. β Cygni. Σ 43 ^r . (1878.) Red images.						
1	3694	Sept. 1	18.3	2.40	+ .25	P.	1	4203	Oct. 6	18.1	2.43	+ .21	P.
2	3695	" "	19.0	2.31	+ .16	P.	2	4204	" "	19.6	2.24	+ .02	S.
3	3718	Sept. 2	26.3	1.53	— .62	S.	3	4264	Oct. 14	23.6	1.80	— .42	S.
4	3719	" "	18.7	2.35	+ .20	S.	4	4269	" "	20.7	2.12	— .10	U.
5	3720	" "	19.5	2.26	+ .11	U.	5	4324	Oct. 17	17.4	2.52	+ .30	P.
6	3721	" "	21.9	1.98	— .17	U.					2.22	$\pm$.21	
7	3807	Sept. 10	19.5	2.26	+ .11	P.							
8	3808	" "	20.4	2.15	.00	P.							
9	3887	Sept. 17	18.4	2.39	+ .24	U.							
10	3888	" "	22.9	1.87	— .28	U.							
				2.15	$\pm$.21								

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
209. β CYGNI. Σ 43 ^I . (1878.) Yellow images.							ϵ SAGITTÆ. Σ Un. (continued).						
1	4205	Oct. 6	21.5	2.02	.00	P.	5	3209	July 7	12.4	3.29	+.19	P.
2	4206	" "	21.4	2.04	+.02	S.	6	3210	" "	14.0	3.02	-.08	P.
3	4265	Oct. 14	23.1	1.85	-.17	S.	7	3283	July 15	14.7	2.91	-.19	P.
4	4270	" "	22.8	1.88	-.14	U.	8	3284	" "	12.8	3.22	+.12	P.
5	4325	Oct. 17	19.0	2.31	+.29	P.	9	3285	" "	15.4	2.80	-.30	S.
				2.02	$\pm$.12		10	3286	" "	16.2	2.68	-.42	S.
											3.10	$\pm$.26	
210. β CYGNI. Σ 43 ^I . (1878.) Green images.							215. 17 χ CYGNI. Σ 2580. (1878.)						
1	4207	Oct. 6	25.8	1.58	-.07	P.	1	3213	July 7	12.3	3.30	-.20	P.
2	4208	" "	22.4	1.93	+.28	S.	2	3214	" "	11.0	3.56	+.06	P.
3	4266	Oct. 14	25.7	1.59	-.06	S.	3	3275	July 15	10.9	3.57	+.07	P.
4	4271	" "	26.6	1.50	-.15	U.	4	3276	" "	11.1	3.53	+.03	P.
5	4326	Oct. 17	25.0	1.65	.00	P.	5	3277	" "	11.1	3.54	+.04	S.
				1.65	$\pm$.11		6	3278	" "	12.5	3.27	-.23	S.
211. β CYGNI. Σ 43 ^I . (1878.) Blue images.							7	3301	July 16	10.8	3.59	+.09	S.
1	4209	Oct. 6	30.4	1.16	+.23	P.	8	3302	" "	10.6	3.64	+.14	S.
2	4210	" "	34.1	.84	-.09	S.	9	3303	July 17	12.5	3.27	-.23	P.
3	4267	Oct. 14	36.9	.62	-.31	S.	10	3304	" "	10.2	3.73	+.23	P.
4	4272	" "	32.8	.96	+.03	U.					3.50	$\pm$.13	
5	4327	Oct. 17	31.6	1.05	+.12	P.							
				.93	$\pm$.16		216. ζ SAGITTÆ. Σ 2585. (1878.)						
212. β CYGNI. Σ 43 ^I . (1878.) Indigo images.							1	3176	July 5	9.85	3.80	+.13	S.
1	4211	Oct. 6	36.7	.64	+.01	P.	2	3177	" "	10.45	3.67	.00	S.
2	4212	" "	36.0	.69	+.06	S.	3	3178	" "	10.50	3.66	-.01	U.
3	4268	Oct. 14	40.5	.34	-.29	S.	4	3179	" "	10.50	3.66	-.01	U.
4	4273	" "	40.5	.34	-.29	U.	5	3211	July 7	11.23	3.51	-.16	P.
5	4328	Oct. 17	30.7	1.13	+.50	P.	6	3212	" "	9.52	3.88	+.21	P.
				.63	$\pm$.23		7	3279	July 15	11.10	3.53	-.14	S.
213. β CYGNI. Σ 43 ^I . (1878.) Violet images.							8	3280	" "	10.02	3.76	+.09	S.
1	4274	Oct. 14	41.6	.26	-.13	U.	9	3281	" "	10.60	3.64	-.03	P.
2	4329	Oct. 17	38.1	.53	+.14	P.	10	3282	" "	11.10	3.54	-.13	P.
				.39	$\pm$.13						3.67	$\pm$.09	
214. ϵ SAGITTÆ. Σ Un. (1878.)							217. ϵ DRACONIS. Σ 2603. (1877-78.)						
1	3170	July 5	11.5	3.45	+.35	U.	1	1001	Dec. 20	11.4	3.48	+.32	S.
2	3171	" "	15.4	2.80	-.30	U.	2	1002	" "	11.9	3.38	+.22	S.
3	3172	" "	12.2	3.33	+.23	S.	3	1138	Dec. 26	13.6	3.08	-.08	P.
4	3173	" "	11.0	3.55	+.45	S.	4	1139	" "	14.9	2.87	-.29	S.
							5	1140	" "	12.0	3.36	+.20	P.
							6	1141	" "	13.0	3.24	+.08	S.
							7	1282	Jan. 9	12.7	3.23	+.07	S.
							8	1283	" "	16.7	2.62	-.54	S.
							9	1321	Jan. 13	12.4	3.39	+.23	P.
							10	1322	" "	14.4	2.95	-.21	P.
											3.16	$\pm$.21	

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218. ϵ DRACONIS. Σ 2603. (1878.) Repeated.							P. XX 63, α^2 CYGNI. Σ 50 ¹ (continued).						
1	3613	Aug. 27	15.0	2.86	-.02	U.	7	3267	July 15	15.2	2.83	-.32	P.
2	3614	" "	15.5	2.78	-.10	U.	8	3268	" "	13.5	3.10	-.05	P.
3	3823	Sept. 12	13.7	3.07	+.19	P.	9	3269	" "	13.4	3.12	-.03	S.
4	3824	" "	15.2	2.83	-.05	P.	10	3270	" "	11.9	3.38	+.23	S.
5	3825	" "	13.5	3.10	+.22	S.					3.15	$\pm .14$	
6	3826	" "	14.3	2.97	+.09	S.	222. α CEPHEI. Σ 2675. (1877.)						
7	3866	Sept. 16	14.3	2.97	+.09	S.	1	866	Dec. 13	11.10	3.54	-.14	S.
8	3867	" "	17.9	2.46	-.42	S.	2	867	" "	11.70	3.42	-.26	S.
9	3889	Sept. 17	14.1	3.00	+.12	P.	3	868	" "	10.77	3.60	-.08	U.
10	3890	" "	15.9	2.72	-.16	P.	4	869	" "	10.50	3.66	-.02	U.
				2.88	$\pm .15$		5	1092	Dec. 25	9.27	3.93	+.25	P.
219. ψ CYGNI. Σ 2605. (1877.)							6	1093	" "	10.10	3.75	+.07	P.
1	826	Dec. 8	21.4	2.03	-.47	P.	7	1176	Dec. 27	10.80	3.60	-.08	P.
2	827	" "	18.1	2.43	-.02	S.	8	1177	" "	10.47	3.66	-.02	S.
3	828	" "	16.3	2.67	+.17	U.	9	1178	" "	9.20	3.95	+.27	P.
4	829	" "	16.9	2.59	+.09	U.	10	1179	" "	10.17	3.73	+.05	S.
5	830	" "	15.9	2.73	+.23	S.					3.68	$\pm .12$	
6	831	" "	19.9	2.21	-.29	P.	223. β CAPRICORNI. Σ 52 ¹ . (1878.) W. Equat.						
7	993	Dec. 20	16.3	2.67	+.17	S.	1	3801	Sept. 9	15.4	2.80	+.05	U.
8	994	" "	18.4	2.39	-.11	P.	2	3802	" "	12.7	3.23	+.48	U.
9	995	" "	18.4	2.39	-.11	S.	3	3885	Sept. 16	15.0	2.86	+.11	P.
10	996	" "	16.1	2.70	+.20	P.	4	3886	" "	17.1	2.56	-.19	P.
11	1038	Dec. 23	14.3	2.97	+.47	P.	5	3932	Sept. 18	14.7	2.91	+.16	S.
12	1039	" "	18.3	2.40	-.10	S.	6	3933	" "	18.7	2.35	-.40	S.
13	1040	" "	18.6	2.36	-.14	P.	7	3953	Sept. 19	11.5	3.45	+.70	P.
14	1041	" "	18.0	2.44	-.06	S.	8	3954	" "	15.3	2.81	+.06	P.
				2.50	$\pm .19$		9	4024	Sept. 23	19.9	2.21	-.54	S.
220. 26 CYGNI. Σ Un. (1877-78.)							10	4025	" "	18.6	2.36	-.39	S.
1	997	Dec. 20	11.00	3.56	-.31	P.					2.75	$\pm .31$	
2	998	" "	9.02	3.99	+.12	P.	224. β DELPHINI. Σ 2704. (1877.)						
3	999	" "	8.72	4.07	+.20	S.	1	816	Dec. 8	2.70	6.63	-.26	S.
4	1000	" "	11.15	3.53	-.34	S.	2	1059	Dec. 24	2.02	7.26	+.37	P.
5	1034	Dec. 23	9.32	3.92	+.05	P.	3	1122	Dec. 26	3.40	6.13	-.76	S.
6	1035	" "	8.90	4.03	+.16	S.	4	1123	" "	2.12	7.15	+.26	P.
7	1036	" "	9.95	3.78	-.09	P.	5	1124	" "	2.90	6.48	-.41	P.
8	1037	" "	8.90	4.03	+.16	S.	6	1125	" "	2.77	6.57	-.32	S.
9	1319	Jan. 13	9.47	3.89	+.02	P.	7	1152	Dec. 27	1.97	7.31	+.42	P.
10	1320	" "	9.40	3.90	+.03	P.	8	1153	" "	2.02	7.28	+.39	S.
				3.87	$\pm .15$		9	1154	" "	2.10	7.18	+.29	P.
221. P. XX 63, α^2 CYGNI. Σ 50 ¹ . (1878.)							10	1155	" "	2.32	6.96	+.07	S.
1	3180	July 5	11.6	3.44	+.29	S.					6.89	$\pm .36$	
2	3181	" "	13.5	3.10	-.05	S.	225. 52 CYGNI. Σ 2726. (1877.)						
3	3182	" "	14.5	2.93	-.22	U.	1	797	Dec. 7	7.85	4.30	-.49	S.
4	3183	" "	13.5	3.10	-.05	U.	2	798	" "	6.30	4.78	-.01	U.
5	3217	July 7	13.2	3.15	.00	P.	3	799	" "	6.85	4.60	-.19	U.
6	3218	" "	12.1	3.35	+.20	P.							

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
52 CYGNI. Σ 2726 (continued).							61 CYGNI. Σ 2758 (continued).						
4	1148	Dec. 27	5.92	4.92	+.13	P.	8	3272	July 15	35.6	.73	-.07	S.
5	1149	" "	6.57	4.69	-.10	S.	9	3273	" "	35.5	.73	-.07	P.
6	1150	" "	5.50	5.08	+.29	P.	10	3274	" "	33.0	.93	+.13	P.
7	1151	" "	5.72	4.99	+.20	S.					0.80	$\pm .09$	
8	1184	Dec. 28	6.25	4.80	+.01	P.	229. δ EQUULEI. Σ 2777. (1877.)						
9	1185	" "	6.72	4.64	-.15	S.	1	1062	Dec. 24	3.85	5.86	+.03	P.
10	1186	" "	6.40	4.75	-.04	P.	2	1063	" "	4.10	5.72	-.11	P.
11	1187	" "	5.45	5.10	+.31	S.	3	1126	Dec. 26	3.55	6.04	+.21	P.
				4.79	$\pm .17$		4	1127	" "	3.62	5.99	+.16	P.
226. γ DELPHINI. Σ 2727. (1877.)							5	1128	" "	3.90	5.83	.00	S.
1	812	Dec. 8	34.4	.82	-.17	P.	6	1129	" "	4.10	5.72	-.11	S.
2	813	" "	30.3	1.17	+.18	S.	7	1156	Dec. 27	3.40	6.13	+.30	P.
3	814	" "	31.3	1.08	+.09	P.	8	1157	" "	3.67	5.96	+.13	S.
4	815	" "	29.8	1.21	+.22	S.	9	1158	" "	4.60	5.47	-.36	P.
5	1060	Dec. 24	32.3	1.00	+.01	P.	10	1159	" "	4.40	5.57	-.26	S.
6	1061	" "	33.0	.94	-.05	P.					5.83	$\pm .17$	
7	1130	Dec. 26	35.0	.78	-.21	S.	230. 1 PEGASI. Σ 11 ^{II} . (1877.)						
8	1131	" "	31.8	1.04	+.05	S.	1	789	Dec. 7	6.17	4.83	-.25	S.
9	1142	Dec. 27	33.2	.92	-.07	P.	2	790	" "	4.75	5.40	+.32	P.
10	1143	" "	32.8	.95	-.04	P.	3	791	" "	6.25	4.80	-.28	P.
				.99	$\pm .11$		4	792	" "	5.25	5.18	+.10	S.
227. f^1 CYGNI. Σ 2743. (1877.)							5	967	Dec. 17	5.05	5.27	+.19	P.
1	800	Dec. 7	6.30	4.78	+.32	U.	6	968	" "	5.42	5.11	+.03	P.
2	801	" "	6.60	4.68	+.22	U.	7	1160	Dec. 27	5.80	4.97	-.11	S.
3	802	" "	6.42	4.75	+.29	S.	8	1161	" "	5.35	5.14	+.06	S.
4	803	" "	7.12	4.52	+.06	P.	9	1166	" "	5.62	5.03	-.05	P.
5	804	" "	7.10	4.52	+.06	S.	10	1167	" "	5.45	5.10	+.02	P.
6	805	" "	7.10	4.52	+.06	P.					5.08	$\pm .14$	
7	883	Dec. 14	8.30	4.18	-.28	P.	231. β CEPHEI. Σ 2806. (1877.)						
8	884	" "	8.02	4.26	-.20	S.	1	858	Dec. 13	7.65	4.36	-.09	S.
9	885	" "	7.20	4.49	+.03	S.	2	859	" "	8.55	4.12	-.33	S.
10	886	" "	8.52	4.13	-.33	U.	3	860	" "	7.27	4.47	+.02	U.
11	887	" "	9.10	3.98	-.48	U.	4	861	" "	6.80	4.62	+.17	U.
12	948	Dec. 16	7.05	4.54	+.08	P.	5	1094	Dec. 25	6.52	4.71	+.26	P.
13	949	" "	6.80	4.62	+.16	P.	6	1095	" "	7.22	4.48	+.03	P.
				4.49	$\pm .20$		7	1134	Dec. 26	7.27	4.47	+.02	P.
228. 61 CYGNI. Σ 2758. (1878.)							8	1135	" "	8.27	4.19	-.26	S.
1	3184	July 5	38.4	.50	-.30	U.	9	1136	" "	7.25	4.48	+.03	S.
2	3185	" "	34.2	.84	+.04	U.	10	1137	" "	6.72	4.64	+.19	P.
3	3186	" "	34.9	.78	-.02	P.					4.45	$\pm .14$	
4	3187	" "	34.3	.83	+.03	P.	232. ε PEGASI. (1878.) W. Equat.						
5	3215	July 7	34.1	.85	+.05	P.	1	3881	Sept. 16	3.90	5.83	-.05	U.
6	3216	" "	34.5	.81	+.01	P.	2	3882	" "	3.65	5.97	+.09	U.
7	3271	July 15	32.6	.97	+.17	S.	3	3949	Sept. 19	3.17	6.28	+.40	U.
							4	3950	" "	3.93	5.81	-.07	U.

TABLE IV.—LEDGER OF BRIGHT DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
ϵ PEGASI (continued).							236. ζ AQUARI. Σ 2909. (1877.)						
5	3951	Sept. 19	3.27	6.21	+ .33	P.	1	817	Dec. 8	38.8	.47	+ .29	P.
6	3952	" "	3.73	5.93	+ .05	P.	2	818	" "	40.6	.33	+ .15	P.
7	3976	Sept. 20	4.57	5.48	— .40	P.	3	819	" "	45.4	— .03	— .21	U.
8	3977	" "	3.27	6.21	+ .33	P.	4	820	" "	44.0	.08	— .10	U.
9	3978	" "	4.43	5.56	— .32	S.	5	1064	Dec. 24	46.9	— .14	— .32	P.
10	3979	" "	4.45	5.54	— .34	S.	6	1065	" "	41.4	.27	+ .09	P.
				5.88	$\pm$.24		7	1201	Dec. 29	41.9	.24	+ .06	P.
							8	1202	" "	44.9	.01	— .17	P.
							9	1203	" "	41.7	.25	+ .07	S.
							10	1204	" "	41.4	.27	+ .09	S.
											.18	$\pm$.16	
233. μ CYGNI. Σ 2822. (1877.)							237. β PISCIS AUSTRINI. (1878.)						
1	821	Dec. 8	28.2	1.35	— .14	P.	1	3461	Aug. 7	9.12	3.97	+ .47	P.
2	822	" "	25.6	1.60	+ .11	U.	2	3462	" "	11.47	3.46	— .04	P.
3	823	" "	25.9	1.57	+ .08	U.	3	3862	Sept. 15	12.32	3.30	— .20	P.
4	824	" "	28.3	1.34	— .15	P.	4	3863	" "	10.45	3.25	— .25	P.
5	825	" "	26.4	1.52	+ .03	S.	5	3864	" "	12.27	3.29	— .21	S.
6	845	Dec. 9	32.0	1.02	— .47	P.	6	3865	" "	12.85	3.21	— .29	S.
7	846	" "	26.2	1.54	+ .05	P.	7	3899	Sept. 17	10.70	3.62	+ .12	U.
8	852	Dec. 13	22.0	1.97	+ .48	U.	8	3900	" "	10.75	3.61	+ .11	U.
9	853	" "	22.5	1.92	+ .43	U.	9	3901	" "	8.85	4.03	+ .53	S.
10	950	Dec. 16	26.3	1.53	+ .04	P.	10	3902	" "	12.43	3.28	— .22	S.
11	951	" "	28.9	1.29	— .20	P.					3.50	$\pm$.24	
12	969	Dec. 17	27.8	1.39	— .10	P.							
13	970	" "	28.4	1.33	— .16	P.							
				1.49	$\pm$.19								
234. κ PEGASI. Σ 2824. (1877.)							238. δ CEPHEI. Σ 581. (1877.)						
1	1162	Dec. 27	4.27	5.63	— .09	P.	1	862	Dec. 13	19.9	2.21	— .26	U.
2	1163	" "	4.12	5.71	— .01	S.	2	863	" "	21.5	2.02	— .45	U.
3	1164	" "	4.07	5.76	+ .04	P.	3	864	" "	17.9	2.46	— .01	S.
4	1165	" "	3.87	5.84	+ .12	S.	4	865	" "	17.5	2.51	+ .04	S.
5	1188	Dec. 28	4.00	5.78	+ .06	P.	5	1098	Dec. 25	13.4	3.11	+ .64	P.
6	1189	" "	3.77	5.90	+ .18	S.	6	1099	" "	15.8	2.74	+ .27	P.
7	1190	" "	4.45	5.55	— .17	P.	7	1172	Dec. 27	17.1	2.56	+ .09	P.
8	1191	" "	4.52	5.51	— .21	S.	8	1173	" "	20.4	2.15	— .32	S.
9	1205	Dec. 29	3.67	5.96	+ .24	P.	9	1174	" "	18.0	2.44	— .03	P.
10	1206	" "	3.92	5.82	+ .10	S.	10	1175	" "	17.4	2.52	+ .05	S.
11	1207	" "	4.65	5.45	— .27	P.					2.47	$\pm$.22	
12	1208	" "	4.20	5.67	— .05	S.							
				5.72	$\pm$.13								
235. ξ CEPHEI. Σ 2863. (1877.)							239. ψ^1 AQUARI. Σ 12 ^{II} . (1877.)						
1	854	Dec. 13	22.2	1.94	— .03	U.	1	1017	Dec. 22	6.32	4.78	+ .15	P.
2	855	" "	23.9	1.77	— .20	U.	2	1018	" "	7.42	4.42	— .21	S.
3	856	" "	22.6	1.90	— .07	S.	3	1019	" "	6.60	4.68	+ .05	P.
4	857	" "	21.9	1.98	+ .01	S.	4	1020	" "	5.92	4.92	+ .29	S.
5	1096	Dec. 25	22.8	1.88	— .09	P.	5	1066	Dec. 24	7.05	4.54	— .09	P.
6	1097	" "	21.6	2.01	+ .04	P.	6	1067	" "	6.95	4.57	— .06	P.
7	1168	Dec. 27	20.2	2.17	+ .20	P.	7	1192	Dec. 28	6.87	4.59	— .04	S.
8	1169	" "	21.7	2.00	+ .03	S.	8	1193	" "	7.60	4.37	— .26	S.
9	1170	" "	20.0	2.20	+ .23	P.	9	1194	" "	6.95	4.57	— .06	P.
10	1171	" "	22.9	1.87	— .10	S.	10	1195	" "	6.20	4.82	+ .19	P.
				1.97	$\pm$.10						4.63	$\pm$.14	

The image of α *Canis Majoris* could not be made to disappear in the third set of No. 92. It could not even be reduced to equality with its companion. After making two settings, which differed only two tenths of a degree, the observation was abandoned. This set has therefore not been included in the mean. If inserted, the difference in magnitude of the two components becomes 10.19 instead of 10.02, and the average deviation .59 instead of .45. A similar difficulty was experienced in the ninth set of No. 2. The bright image of α *Andromedæ* would not disappear. Six readings gave the differences 0.5, 0.0, and 0.1. As the set was complete and no good reason could be given for its rejection, it has been retained. If rejected, the mean becomes 9.56 and the average deviation .59.

The third and fourth sets of No. 110 are not reduced. Either the wrong star was observed, or the principal image was compared with its reflection. The eighth set of No. 159 has not been used in the mean. The set was abandoned after three readings on account of the poorness of the seeing.

The first set of No. 189 has also been rejected. The record makes it doubtful whether the reading should be 52.75 or 37.25. When the components differ but little in brightness, care should always be taken to make one of the images to be compared disappear, and record this fact and the corresponding circle reading. In the present case, the record implies that α in Fig. 7, page 105, disappears when the reading is 152.60. As the observation is one of the first made with this instrument, it is not improbable that a mistake was made in the images. Probably B disappeared, and the reading should be 32.75. The difference in magnitude then becomes +.60. The northern component is unmistakably the brighter, and a measurement making it so much the fainter of the two could hardly be due to errors of setting. If retained, the mean difference would become .20 and the average deviation .20.

Table V. gives the results of Table IV. in the form of a Catalogue. The corresponding lines on the left and right hand pages relate to the same object. The first three columns on the left hand page give the number, name, and reference to the Dorpat Catalogue used in Table IV. The next five columns give the right ascension and declination reduced to 1875.0, the mean epoch of Struve's observations to the nearest year, the position angle to the nearest tenth of a degree, and the distance to the nearest tenth of a second. For the present purpose, accuracy in these quantities is not required. When the star is binary, it is so denoted in the column of remarks on the right hand page, followed by the approximate position angle and distance at the present time, thus: Bin. 140° , $5''.8$.

The last four columns of the left hand page give the color and magnitudes according to Struve, adopting the translations of the Dun Echt Catalogue. The annexed system of abbreviations is used. When a color is preceded by an adjective

ending in *sh*, these letters are omitted; thus, *bl. gr.* is to be read bluish green. The words *ash* and *ashy* are not abbreviated, except that *a.w.* denotes ashy white.

When the star was not observed by Struve, the magnitudes and positions are taken from other authorities, often from Webb's "Celestial Objects for Common Telescopes."

The first and second columns of the right hand page are the same as those of the left hand page. The third column gives the number of sets taken. The fourth column gives the means of the observed magnitudes found in Table IV. The next column contains the logarithm of the light of the fainter star divided by that of the brighter star. It is found from the preceding column by multiplying by four-tenths, and subtracting the result from 10.000. The sixth column gives the light of the bright star in terms of the light of the faint star. This quantity is given instead of its reciprocal, because the mind conceives of a larger number more readily than of a minute fraction. Thus, five hundred is more clearly appreciated than two one-thousandths. Column six is derived from column four by multiplying by four-tenths and taking the anti-logarithm. The seventh column gives the average deviation in magnitudes of the individual measurements of each star in Table IV. from their mean. The eighth column gives the probable error of the mean value contained in the fourth column. It was computed from the average deviations by a table based upon Peters' formula for probable errors.

The last column but one of Table V. shows the agreement of the measurements with the magnitudes estimated by Struve. The fourth column of the right hand page is subtracted from the difference of the last two columns of the left hand page. If, therefore, we assume that the estimate of the brighter star is correct, a positive sign denotes that the brightness of the faint component, according to the present measurement, exceeds that which Struve's estimate assigns to it by the amount given in this column.

The last column of the page is devoted to remarks, which in most cases are the same as in Table IV.

bl.	indicates	blue.
blsh.	"	bluish.
go.	"	golden.
gr.	"	green.
grsh.	"	greenish.
i.	"	intense.
ol.	"	olive.
p.	"	purplish.
r.	"	red.
rsh.	"	reddish.
v.	"	very.
w.	"	white.
y.	"	yellow.
ysh.	"	yellowish.

TABLE V.

CATALOGUE OF BRIGHT DOUBLE STARS.

No.	Name.	Σ	R.A., 1875.		Dec., 1875.	Date.	Angle.	Dist.	Color.		Magn.	
			h.	m.					A.	B.	A.	B.
1	α Andromedæ .	13 ^{II}	0	1.9	+28 24	1836	266.5	65.0	w.	—	2.0	11.1
2	" .	"	"	"	"	"	"	"	"	"	"	"
3	51 Piscium . .	36	0	25.8	+ 6 15	1833	82.3	27.4	w.	ash.	5.5	9.5
4	π Andromedæ .	—	0	30.2	+33 02	—	173.9	36.	—	—	4.5	9.0
5	α Cassiopeiæ . .	Un.	0	33.4	+55 51	1821	278.5	58.6	—	—	2.5	10.0
6	" .	"	"	"	"	"	"	"	"	"	"	"
7	55 Piscium . .	46	0	33.4	+20 45	1830	192.7	6.4	v. y.	v. bl.	5.0	8.2
8	η Cassiopeiæ . .	60	0	41.3	+57 9	1833	88.6	9.7	y.	p.	4.0	7.6
9	ψ^1 Piscium . .	88	0	58.9	+20 48	1832	160.3	29.9	w.	w.	4.8	5.1
10	φ Piscium . .	99	1	7.0	+23 56	1832	227.5	8.0	v. y.	bl.	4.7	10.1
11	ζ Piscium . .	100	1	7.1	+ 6 55	1833	63.7	23.5	w.	w.	4.7	5.8
12	α Ursæ Minoris .	93	1	13.0	+88 39	1834	210.1	18.3	y.	w.	2.0	9.0
13	" " .	"	"	"	"	"	"	"	"	"	"	"
14	ψ Cassiopeiæ .	117	1	16.9	+67 30	1831	—	—	v. y.	—	4.7	—
15	" .	"	"	"	"	"	"	"	"	"	"	"
16	" .	"	"	"	"	"	101.8	32.2	"	—	"	8.9
17	" .	"	"	"	"	"	104.6	29.3	"	—	"	9.8
18	γ Arietis . .	180	1	46.6	+18 42	1831	0.0	8.6	v. w.	v. w.	4.2	4.4
19	λ Arietis . .	Un.	1	50.9	+23 0	1820	45.6	38.1	v. w.	v. w.	4.9	7.7
20	α Piscium . .	202	1	55.5	+ 2 9	1831	335.7	3.6	gr. w.	bl.	3.0	4.4
21	γ Andromedæ .	205	1	56.3	+41 44	1830	62.4	10.3	go.	bl.	3.0	5.0
22	" .	"	"	"	"	"	"	"	"	"	"	"
23	" .	"	"	"	"	"	"	"	"	"	"	"
24	" .	"	"	"	"	"	"	"	"	"	"	"
25	" .	"	"	"	"	"	"	"	"	"	"	"
26	" .	"	"	"	"	"	"	"	"	"	"	"
27	" .	"	"	"	"	"	"	"	"	"	"	"
28	" .	"	"	"	"	"	"	"	"	"	"	"
29	ι Trianguli . .	227	2	5.2	+29 43	1831	77.9	3.6	y.	bl.	5.5	7.2
30	$\circ$ Ceti . .	Un.	2	13.1	— 3 32	1821	88.6	95.4	—	—	var.	—
31	" . .	"	"	"	"	"	"	"	"	"	"	"
32	ι Cassiopeiæ . .	262	2	18.8	+66 51	1830	276.7	1.9	y.	bl.	4.7	7.3
33	" . .	"	"	"	"	"	107.3	7.6	"	"	"	8.6
34	ν Ceti . .	281	2	28.2	+ 5 2	1832	83.3	7.7	y.	ash.	5.0	9.6
35	ω Fornacis . .	—	2	28.4	—28 47	—	242.	11.	—	—	5.0	8.0
36	θ Persei . .	296	2	35.7	+48 43	1832	294.6	15.4	y.	—	4.1	10.5
37	γ Ceti . .	299	2	36.7	+ 2 42	1832	287.4	2.6	ysh.	ash.	3.0	6.8
38	η Persei . .	307	2	41.6	+55 23	1831	300.4	28.0	v. y.	v. bl.	4.0	8.5
39	π Arietis . .	311	2	42.1	+16 58	1832	119.3	3.3	y. w.	—	5.4	8.7
40	" . .	"	"	"	"	1833	110.1	25.2	"	—	"	10.2
41	41 Arietis . .	Un.	2	42.7	+26 45	1822	225.4	119.7	—	—	5.0	9.0
42	θ Eridani . .	—	2	53.5	—40 48	—	81.	9.	—	—	5.0	6.0
43	2 H. Camelop. .	385	3	18.9	+59 30	1830	161.4	2.4	y.	—	4.7	9.0
44	4 H. Camelop. .	390	3	20.5	+55 01	1832	159.6	15.0	gr. w.	—	4.8	9.2

TABLE V.

CATALOGUE OF BRIGHT DOUBLE STARS.

No.	Name.	No. of Sets.	Diff. in Magn.	Log.	Ratio.	Average Dev.	Prob. Error.	$\Sigma - O.$	Remarks.
1	α Andromedæ .	10	8.32	6.672	2130.	.13	.04	+ .78	Variable?
2	" .	11	9.81	6.076	8390.	.81	.22	- .71	Repeated.
3	51 Piscium . .	12	3.60	8.560	275.0	.16	.04	+ .40	
4	π Andromedæ .	10	4.25	8.300	50.10	.06	.02		
5	α Cassiopeiæ . .	12	6.62	7.352	445.0	.14	.04	+ .88	
6	" . .	12	6.46	7.416	384.0	.25	.06	+ 1.04	Repeated.
7	55 Piscium . .	13	3.27	8.692	20.30	.14	.03	- .07	
8	η Cassiopeiæ . .	10	3.85	8.460	34.70	.16	.05	- .25	Bin. 140°, 5".8.
9	ψ^1 Piscium . .	10	.20	9.920	1.200	.13	.04	+ .10	
10	ϕ Piscium . . .	13	5.07	7.972	107.0	.14	.03	+ .33	
11	ζ Piscium . . .	10	.96	9.616	2.420	.08	.02	+ .14	
12	α Ursæ Minoris .	12	6.57	7.372	425.0	.12	.03	+ .43	
13	" " .	16	6.67	7.332	466.0	.19	.04	+ .33	Repeated.
14	ψ Cassiopeiæ . .	19	4.46	8.216	60.80	.55	.11		A, BC.
15	" . .	12	4.81	8.076	83.90	.20	.05		A, BC. Repeated.
16	" . .	6	5.36	7.856	139.0	.28	.11	- .86	A, B.
17	" . .	2	5.92	7.632	233.0	.03	.03	- .82	A, C.
18	γ Arietis . . .	12	-.06	.024	.946	.11	.03	+ .26	
19	λ Arietis . . .	10	2.51	8.996	10.10	.09	.03	+ .29	
20	α Piscium . . .	13	.90	9.640	2.290	.12	.03	+ .50	Bin. 322°, 3".1.
21	γ Andromedæ .	10	2.85	8.860	13.80	.09	.03	- .85	
22	" .	2	3.26	8.696	20.10	.01	.01	- 1.26	Red glass.
23	" .	2	2.60	8.960	11.00	.01	.01	- .60	Blue glass.
24	" .	5	3.07	8.772	16.90	.03	.01	- 1.07	Red images.
25	" .	5	3.14	8.744	18.00	.19	.08	- 1.14	Yellow images.
26	" .	5	2.71	8.916	12.10	.22	.09	- .71	Green images.
27	" .	5	2.61	8.956	11.10	.23	.10	- .61	Blue images.
28	" .	4	1.74	9.304	4.970	.57	.28	+ .26	Indigo images.
29	ι Trianguli . .	12	1.56	9.376	4.210	.15	.04	+ .14	
30	σ Ceti . . .	6	5.05	7.980	105.0	.10	.04		Variable.
31	" . . .	10	6.68	7.328	470.0	.26	.07		Variable.
32	ι Cassiopeiæ . .	10	2.26	9.096	8.020	.29	.08	+ .34	A, B. Bin. 265°, 2".1.
33	" . .	11	3.43	8.628	23.50	.16	.04	+ .47	A, C.
34	ν Ceti . . .	11	4.56	8.176	66.70	.18	.05	+ .04	B 16 magn. Herschel.
35	ω Fornacis . .	10	2.76	8.896	12.70	.09	.03		
36	θ Persei . . .	12	5.64	7.744	180.0	.22	.06	+ .76	
37	γ Ceti . . .	35	2.47	9.012	9.730	.24	.03	+ 1.33	
38	η Persei . . .	12	4.74	8.104	78.70	.19	.05	- .24	
39	π Arietis . . .	12	2.91	8.836	14.60	.09	.02	+ .39	A, B.
40	" . . .	13	5.79	7.684	207.0	.21	.05	- .99	A, C.
41	41 Arietis . . .	14	5.42	7.832	147.0	.41	.10	- 1.42	
42	θ Eridani . . .	11	1.09	9.564	2.730	.12	.03		
43	2 H. Camelop. .	14	4.09	8.364	43.20	.37	.09	+ .21	
44	4 H. Camelop. .	12	4.63	8.148	71.10	.10	.03	- .23	

No.	Name.	Σ	R. A., 1875.		Dec., 1875.		Date.	Angle.	Dist.	Color.		Magn.	
			<i>h.</i>	<i>m.</i>	<i>°</i>	<i>'</i>				A.	B.	A.	B.
45	α Persei . . .	431	3	34.5	+ 33	34	1830	237.2	20.0	gr. w.	—	4.2	9.5
46	η Tauri . . .	81	3	40.1	+ 23	44	1836	289.3	117.2	gr. w.	w.	3.8	7.0
47	" . . .	"	"	"	"	"	"	"	"	"	"	"	"
48	β Tauri . . .	452	3	41.2	+ 10	46	1831	57.9	8.9	bl. gr.	—	4.8	9.8
49	γ Eridani . . .	—	3	44.0	— 38	0	—	200.	9.	—	—	5.0	5.0
50	ζ Persei . . .	464	3	46.3	+ 31	30	1831	207.6	12.5	gr. w.	ash.	2.7	9.3
51	δ Eridani . . .	470	3	48.1	— 3	18	1833	347.3	6.7	y.	bl.	4.3	6.2
52	ϵ Persei . . .	471	3	49.5	+ 39	39	1833	9.2	8.8	gr.	bl. w.	3.0	8.5
53	ζ Eridani . . .	516	4	8.3	— 10	35	1832	153.9	6.3	y.	bl.	5.8	9.0
54	η Eridani . . .	518	4	9.6	— 7	48	1825	107.5	85.3	v. y.	—	4.3	9.6
55	α Tauri . . .	211	4	28.7	+ 16	16	1836	36.0	109.0	go.	—	1.0	11.2
56	δ Tauri . . .	—	4	28.8	+ 9	54	—	300.4	68.	—	—	5.0	8.5
57	τ Tauri . . .	—	4	34.7	+ 22	43	—	209.8	62.	—	—	5.0	8.0
58	γ Camelop. . .	610	4	47.2	+ 53	32	1832	238.3	25.6	w.	—	4.2	11.3
59	ω Aurigæ . . .	616	4	50.6	+ 37	43	1829	351.9	6.5	grsh.	bl. w.	4.1	8.3
60	11, 12 Camelop. .	131	4	55.1	+ 58	49	1836	7.1	181.3	blsh.	v. y.	5.0	6.0
61	19 H. Camelop. .	634	5	2.1	+ 79	4	1834	348.6	34.0	ysh.	w.	4.5	7.9
62	ι Leporis . . .	655	5	6.6	— 12	1	1832	337.6	12.8	grsh.	—	4.2	10.5
63	ρ Orionis . . .	654	5	6.7	+ 2	45	1832	63.5	7.1	v. y.	bl.	4.7	8.5
64	14 Aurigæ . . .	653	5	7.3	+ 32	33	1831	225.5	14.7	grsh.	bl. w.	5.0	7.8
65	κ Leporis . . .	661	5	7.4	— 13	05	1832	358.7	3.1	ysh.	bl.	5.0	7.9
66	β Orionis . . .	668	5	8.6	— 8	21	1832	199.8	9.1	y. w.	—	1.0	8.1
67	" . . .	"	"	"	"	"	"	"	"	"	"	"	"
68	23 Orionis . . .	696	5	16.1	+ 3	24	1831	28.1	31.7	gr. w.	w.	5.2	7.2
69	δ Orionis . . .	141	5	25.6	— 0	23	1836	359.2	52.7	gr. w.	w.	2.0	6.9
70	" . . .	"	"	"	"	"	"	"	"	"	"	"	"
71	λ Orionis . . .	738	5	28.3	+ 9	51	1831	40.3	4.2	ysh.	p.	4.2	6.4
72	" . . .	"	"	"	"	"	"	184.0	15.0	"	"	"	11.2
73	θ^1 Orionis . . .	748	5	29.1	— 5	30	1836	240.3	13.3	ysh.	ysh.	4.7	6.3
74	" . . .	"	"	"	"	"	"	299.4	19.2	"	w.	4.7	7.0
75	" . . .	"	"	"	"	"	"	162.1	16.9	"	a. w.	4.7	8.0
76	" . . .	"	"	"	"	"	"	95.4	21.4	"	w.	6.3	7.0
77	" . . .	"	"	"	"	"	"	131.6	13.0	"	a. w.	6.3	8.0
78	" . . .	"	"	"	"	"	"	31.6	8.7	w.	"	7.0	8.0
79	θ^2 Orionis . . .	161	5	29.2	— 5	30	1836	92.0	52.8	ysh.	ashy.	4.8	6.1
80	ι Orionis . . .	752	5	29.4	— 6	01	1832	142.2	11.3	y. w.	blsh.	3.2	7.8
81	26 Aurigæ . . .	753	5	30.4	+ 30	26	1829	268.0	12.3	y.	blsh.	5.9	8.5
82	σ Orionis . . .	762	5	32.5	— 2	41	1831	60.7	41.2	w.	ash.	4.1	7.0
83	" . . .	"	"	"	"	"	"	84.5	12.9	"	"	"	7.5
84	" . . .	"	"	"	"	"	"	236.5	11.0	"	"	"	10.3
85	ζ Orionis . . .	774	5	34.6	— 2	02	1825	153.3	2.3	y.	r. ol.	2.0	5.3
86	" . . .	—	"	"	"	"	—	7.8	56.	"	—	3.0	10.0
87	γ Leporis . . .	—	5	39.3	— 22	29	—	349.	93.	—	—	4.0	6.5
88	8 Monocerotis . .	900	6	17.1	+ 4	40	1832	25.9	13.9	ysh.	blsh.	4.2	7.0
89	11 Monocerotis . .	919	6	22.7	— 6	56	1831	130.0	7.3	w.	w.	5.0	5.5
90	" . . .	"	"	"	"	"	"	101.7	2.5	"	"	5.5	6.0
91	ϵ Geminorum . . .	—	6	36.2	+ 25	15	—	94.1	111.	—	—	3.0	9.5
92	α Canis Majoris . .	—	6	39.7	— 16	32	—	71.	10.	—	—	—	—
93	μ Canis Majoris . .	997	6	50.2	— 13	53	1831	343.5	3.2	y.	bl.	4.7	8.0
94	λ Geminorum . . .	1061	7	10.8	+ 16	46	1830	30.9	9.6	gr. bl.	—	3.2	10.3

TABLE V. — CATALOGUE OF BRIGHT DOUBLE STARS.

No.	Name.	No. of Sets.	Diff. in Magn.	Log.	Ratio.	Average Dev.	Prob. Error.	$\Sigma - O.$	Remarks.
45	α Persei	14	4.82	8.072	84.70	.13	.03	+ .48	Repeated. B 15 magn. Herschel.
46	η Tauri	12	3.25	8.700	20.00	.26	.07	- .05	
47	"	10	3.29	8.684	20.70	.23	.06	- .09	
48	β Tauri	10	4.13	8.348	44.90	.16	.05	+ .87	
49	ζ Eridani	12	.62	9.752	1.770	.13	.03		
50	ζ Persei	14	6.26	7.496	319.0	.12	.03	+ .34	A, BC.
51	β Eridani	10	1.38	9.448	3.560	.13	.04	+ .52	
52	ϵ Persei	10	4.92	8.032	92.90	.21	.06	+ .58	
53	β Eridani	10	3.74	8.504	31.30	.18	.05	- .54	
54	γ Eridani	10	5.27	7.892	128.0	.21	.06	+ .03	
55	α Tauri	11	9.53	6.188	6490.	.36	.10	+ .67	W. Equat. B. v. y. or r.
56	δ Tauri	6	3.45	8.620	24.00	.29	.11		
57	τ Tauri	11	2.92	8.832	14.70	.21	.06		
58	γ Camelop. . . .	10	6.21	7.516	305.0	.19	.05	+ .89	
59	ω Aurigæ	10	2.62	8.952	11.20	.22	.06	+ 1.58	
60	11, 12 Camelop. . .	10	.85	9.660	2.190	.22	.06	+ .15	Repeated.
61	19 H. Camelop. . .	13	3.69	8.524	29.90	.16	.04	- .29	
62	ι Leporis	16	4.87	8.052	88.70	.21	.05	+ 1.43	
63	ρ Orionis	12	3.92	8.432	37.00	.10	.03	- .12	
64	14 Aurigæ	10	2.96	8.816	15.28	.16	.05	- .16	
65	κ Leporis	8	2.63	8.948	11.30	.20	.06	+ .27	Repeated.
66	β Orionis	10	6.25	7.500	316.0	.27	.08	+ .85	
67	"	6	6.29	7.484	328.0	.17	.06	+ .81	
68	23 Orionis	12	2.12	9.152	7.050	.20	.05	- .12	
69	δ Orionis	16	4.35	8.260	54.90	.46	.10	+ .55	
70	"	12	4.40	8.240	57.50	.17	.04	+ .50	Repeated.
71	λ Orionis	10	1.90	9.240	5.750	.15	.04	+ .30	
72	"	12	7.17	7.132	738.0	.19	.05	- .17	
73	θ^1 Orionis	8	1.46	9.416	3.840	.13	.04	+ .14	
74	"	9	1.47	9.412	3.870	.18	.05	+ .83	
75	"	8	2.62	8.952	11.20	.11	.04	+ .68	A, B. A, C. A, B. A, C. A, D. B, C. B, D. C, D.
76	"	8	.15	9.940	1.150	.16	.05	+ .55	
77	"	8	.92	9.632	2.330	.06	.02	+ .78	
78	"	8	1.22	9.512	3.080	.13	.04	- .22	
79	θ^2 Orionis	10	1.51	9.396	4.020	.08	.02	- .21	
80	ι Orionis	12	4.53	8.188	64.90	.12	.03	+ .07	A, B. A, C. A, D. A, B. A, C.
81	26 Aurigæ	10	2.95	8.820	15.10	.16	.05	- .35	
82	σ Orionis	10	2.68	8.928	11.80	.14	.04	+ .22	
83	"	10	2.91	8.836	14.60	.10	.03	+ .49	
84	"	10	5.34	7.864	136.0	.22	.06	+ .86	
85	ζ Orionis	11	2.16	9.136	7.311	.19	.05	+ 1.14	A, B. A, C. A, B. A, C. A, B.
86	"	4	7.88	6.848	1420.	.18	.09		
87	γ Leporis	4	2.32	9.072	8.470	.10	.05		
88	8 Monocerotis . . .	12	2.15	9.140	7.240	.11	.03	+ .65	
89	11 Monocerotis . .	12	.49	9.804	1.570	.08	.02	+ .01	
90	"	11	.38	9.848	1.420	.18	.05	+ .12	[11".0. Sirius & comp. Bin. 50°,
91	ϵ Geminorum . . .	12	5.84	7.664	217.0	.28	.07		
92	α Canis Majoris . .	13	10.02	5.992	10200.	.45	.11		
93	μ Canis Majoris . .	9	2.32	9.072	8.470	.19	.06	+ .98	
94	λ Geminorum . . .	12	6.02	7.592	256.0	.28	.07	+ 1.08	

No.	Name.	Σ	R. A., 1875.	Dec., 1875.	Date.	Angle.	Dist.	Color.		Magn.	
								A.	B.	A.	B.
95	δ Geminorum . . .	1066	^{h.} 7 ^{m.} 12.5	+22 12	1840	196.9	7.1	ysh.	p.	3.3	9.0
96	α Geminorum . . .	1110	7 26.6	+32 9	1826	262.5	4.4	grsh.	grsh.	2.7	3.7
97	" . . .	4 ^{II}	"	"	1835	162.5	72.5	"	—	"	9.8
98	π Puppis . . .	—	7 33.7	-26 31	—	138.	10.	—	—	5.0	5.0
99	π Geminorum . . .	—	7 36.9	+24 42	—	231.9	6.	—	—	4.0	10.0
100	π Geminorum . . .	1135	7 39.4	+33 42	1831	211.7	22.6	go.	—	4.9	11.0
101	ζ Cancri . . .	1196	8 4.9	+18 2	1826	57.6	1.1	y.	y.	5.0	5.7
102	ι Cancri . . .	1268	8 39.0	+29 13	1828	307.1	30.5	y.	blsh.	4.2	6.5
103	ε Hydræ . . .	1273	8 40.2	+6 54	1831	195.6	3.2	y.	bl.	3.8	7.8
104	ι Ursæ Majoris . . .	—	8 50.7	+48 32	—	348.	12.	—	—	3.5	13.0
105	σ^2 Ursæ Majoris . . .	1306	8 59.5	+67 39	1832	263.6	4.6	grsh.	—	5.0	9.1
106	38 Lyncis . . .	1334	9 10.9	+37 20	1829	240.2	2.7	gr. w.	bl.	4.5	7.1
107	23 h Ursæ Majoris . . .	1351	9 21.7	+63 36	1831	272.4	22.8	gr. w.	ash.	3.9	9.2
108	α Leonis . . .	6 ^{II}	10 1.7	+12 35	1836	306.6	176.9	bl. w.	w.	1.2	8.4
109	" . . .	"	"	"	"	"	"	"	"	"	"
110	ζ Leonis . . .	18 ^I	10 9.6	+24 06	1836	343.1	314.4	ysh.	w.	3.8	6.0
111	γ Leonis . . .	1424	10 13.1	+20 29	1832	103.4	2.5	go.	gr. r.	2.2	3.6
112	54 Leonis . . .	1487	10 48.8	+25 26	1830	102.8	6.2	gr. w.	bl.	5.0	7.0
113	ξ Ursæ Majoris . . .	1523	11 11.5	+32 14	1826	238.7	1.7	—	—	4.4	5.3
114	ν Ursæ Majoris . . .	1524	11 11.8	+33 46	1831	146.6	7.1	v. y.	—	3.7	10.1
115	ι Leonis . . .	1536	11 17.3	+11 13	1832	92.4	2.2	ysh.	bl.	3.9	7.1
116	83 Leonis . . .	1540	11 20.5	+3 42	1833	150.0	29.6	w.	w.	6.4	7.4
117	τ Leonis . . .	19 ^I	11 21.5	+3 33	1835	169.6	94.8	y.	w.	5.0	7.0
118	93 Leonis . . .	7 ^{II}	11 41.5	+20 55	1836	355.5	74.3	y.	w.	4.7	8.4
119	17 Comæ Ber. . .	21 ^I	12 22.6	+26 36	1836	250.7	145.4	w.	bl. w.	4.8	6.0
120	δ Corvi . . .	Un.	12 23.4	-15 39	1820	209.7	24.	—	—	3.0	9.0
121	24 Comæ Ber. . .	1657	12 28.7	+19 05	1830	271.9	20.4	v. y.	bl.	4.8	6.6
122	γ Virginis . . .	1670	12 35.3	-0 45	1825	277.9	2.4	ysh.	ysh.	3.0	3.0
123	35 Comæ Ber. . .	1687	12 47.2	+21 55	1830	124.7	28.6	ysh.	bl.	5.0	9.0
124	32 H. Camelop. . .	1694	12 48.3	+84 4	1833	327.2	21.8	v. w.	v. w.	5.2	5.8
125	12 Canum Venat. . .	1692	12 50.2	+39 0	1831	227.3	19.9	w.	w.	3.4	5.6
126	" " . . .	"	"	"	"	"	"	"	"	"	"
127	" " . . .	"	"	"	"	"	"	"	"	"	"
128	" " . . .	"	"	"	"	"	"	"	"	"	"
129	θ Virginis . . .	1724	13 3.4	-4 52	1830	344.0	7.1	w.	—	4.0	9.0
130	" . . .	"	"	"	"	295.	65.	"	"	"	—
131	ζ Ursæ Majoris . . .	1744	13 19.0	+55 36	1831	147.6	14.4	gr. w.	gr. w.	2.6	4.1
132	" " . . .	"	"	"	"	"	"	"	"	"	"
133	" " . . .	"	"	"	"	"	"	"	"	"	"
134	" " . . .	"	"	"	"	"	"	"	"	"	"
135	π Bootis . . .	1821	14 8.9	+52 23	1832	237.7	12.6	grsh.	blsh.	5.0	7.1
136	ι Bootis . . .	3124	14 11.9	+51 57	1836	33.2	38.1	y. w.	w.	4.9	8.3
137	φ Virginis . . .	1846	14 21.9	-1 39	1830	108.8	3.7	y.	—	5.2	9.7
138	π Bootis . . .	1864	14 34.8	+16 58	1830	99.2	5.8	v. w.	v. w.	4.8	5.8
139	ε Bootis . . .	1877	14 39.5	+27 36	1829	321.0	2.6	v. y.	v. b.	3.3	6.6
140	" . . .	"	"	"	"	"	"	"	"	"	"
141	α Libræ . . .	—	14 44.0	-15 31	—	314.3	229.	—	—	3.0	6.0
142	ξ Bootis . . .	1888	14 45.5	+19 37	1829	334.2	7.2	y.	p. r.	4.6	6.9
143	44 Bootis . . .	1909	14 59.6	+48 10	1832	234.1	2.9	ysh.	blsh.	5.2	6.2
144	δ Bootis . . .	27 ^I	15 10.5	+33 47	1836	79.0	104.9	y.	w.	4.1	7.0

TABLE V. — CATALOGUE OF BRIGHT DOUBLE STARS.

No.	Name.	No. of Sets.	Diff. in Magn.	Log.	Ratio.	Average Dev.	Prob. Error.	$\Sigma - O.$	Remarks.
95	δ Geminorum . . .	10	4.47	8.212	61.40	.18	.05	+ 1.23	A, B. Bin. 238°, 5".6. A, C.
96	α Geminorum . . .	10	.82	9.672	2.130	.23	.07	+ .18	
97	" . . .	12	6.91	7.236	581.0	.22	.06	+ .19	
98	π Puppis . . .	10	.01	9.996	1.010	.14	.04		
99	π Geminorum . . .	10	5.69	7.724	189.0	.20	.06		Bin. 132°, 5".4.
100	π Geminorum . . .	14	5.55	7.780	166.0	.24	.06	+ .55	
101	ζ Cancri . . .	12	.93	9.628	2.350	.09	.02	- .23	
102	ι Cancri . . .	10	2.53	8.988	10.30	.17	.05	- .23	
103	ε Hydrae . . .	10	3.24	8.704	19.80	.23	.06	+ .76	Bin. 219°, 3".3.
104	ι Ursae Majoris . .	4	7.07	7.172	673.0	.19	.09		
105	σ^2 Ursae Majoris . .	11	3.28	8.688	20.50	.40	.11	+ .82	
106	38 Lyncis . . .	12	1.85	9.260	5.490	.17	.04	+ .75	
107	23 h Ursae Majoris	10	5.29	7.884	131.0	.12	.03	+ .01	W. Equatorial.
108	α Leonis . . .	10	5.59	7.764	172.0	.29	.08	+ 1.61	
109	" . . .	14	7.03	7.188	649.0	.37	.09	+ .17	
110	ζ Leonis . . .	10	2.05	9.180	6.610	.24	.07	+ .15	
111	γ Leonis . . .	10	1.19	9.524	2.990	.16	.05	+ .21	Bin. 112°, 3".2.
112	54 Leonis . . .	10	1.90	9.240	5.750	.13	.04	+ .10	
113	ξ Ursae Majoris . .	12	.46	9.816	1.530	.14	.04	+ .44	
114	ν Ursae Majoris . .	10	5.54	7.784	164.0	.35	.10	+ .86	
115	ι Leonis . . .	10	2.67	8.932	11.70	.27	.08	+ .53	Bin. 67°, 2".6.
116	83 Leonis . . .	10	1.03	9.588	2.580	.11	.03	- .03	
117	τ Leonis . . .	10	2.72	8.912	12.20	.22	.06	- .72	
118	93 Leonis . . .	10	4.30	8.280	52.50	.17	.05	- .60	
119	17 Comae Beren. . .	4	1.42	9.432	3.700	.36	.18	- .22	W. Equatorial.
120	δ Corvi . . .	10	5.33	7.868	136.0	.24	.07	+ .17	
121	24 Comae Beren. . .	10	1.65	9.340	4.570	.14	.04	+ .15	
122	γ Virginis . . .	12	-.03	0.012	.973	.13	.03	+ .03	
123	35 Comae Beren. . .	10	4.74	8.104	78.70	.37	.10	- .74	Bin. 159°, 4".7. AB, C.
124	32 H. Camelop. . .	10	.53	9.788	1.630	.12	.03	+ .07	
125	12 Canum Venat. . .	10	2.63	8.948	11.30	.17	.05	- .43	
126	" " . . .	10	2.63	8.948	11.30	.12	.03	- .43	
127	" " . . .	10	2.59	8.964	10.90	.15	.04	- .39	Repeated. Aperture 12.7 cms. W. Equatorial.
128	" " . . .	10	2.40	9.040	9.120	.17	.05	- .20	
129	θ Virginis . . .	12	3.77	8.492	32.20	.12	.03	+ 1.23	
130	" . . .	10	6.30	7.480	331.0	.13	.04		
131	ζ Ursae Majoris . .	10	1.56	9.376	4.210	.16	.05	- .06	Repeated. Aperture 12.7 cms. W. Equatorial.
132	" " . . .	10	1.66	9.336	4.610	.11	.03	- .16	
133	" " . . .	10	1.71	9.316	4.830	.11	.03	- .21	
134	" " . . .	10	1.59	9.364	4.320	.16	.05	- .09	
135	π Bootis . . .	12	2.11	9.156	6.980	.14	.04	- .01	Bin. 101°, 5".7.
136	ι Bootis . . .	10	3.40	8.640	22.90	.14	.04	.00	
137	φ Virginis . . .	10	4.00	8.400	39.80	.16	.05	+ .50	
138	π Bootis . . .	10	.92	9.632	2.330	.15	.04	+ .08	
139	ε Bootis . . .	11	2.41	9.036	9.200	.19	.05	+ .89	Bin. 326°, 2".6. Repeated. W. Equatorial.
140	" . . .	10	2.44	9.024	9.460	.19	.05	+ .86	
141	α Librae . . .	13	2.12	9.152	7.050	.21	.05		
142	ξ Bootis . . .	10	2.04	9.184	6.550	.15	.04	+ .26	
143	44 Bootis . . .	10	.80	9.680	2.090	.19	.05	+ .20	Bin. 289°, 4".2.
144	δ Bootis . . .	11	4.79	8.084	824.0	.35	.09	- 1.89	

No.	Name.	No. of Sets.	Diff. in Magn.	Log.	Ratio.	Average Dev.	Prob. Error.	$\Sigma - O.$	Remarks.
145	5 Serpentis . . .	10	4.61	8.156	69.80	.25	.07	+ .49	Bin. 190°, 3".1.
146	μ Bootis . . .	10	2.42	9.032	9.290	.14	.04	- .42	
147	δ Serpentis . . .	10	.93	9.628	2.350	.14	.04	+ .27	
148	ζ Coronæ . . .	12	.89	9.644	2.270	.16	.04	- .29	
149	α Serpentis . . .	10	10.22	5.912	12200.	.50	.14		
150	β Serpentis . . .	10	6.21	7.516	305.0	.26	.07	+ .59	A, BC. A, B. A, C.
151	η Lupi . . .	10	4.18	8.328	47.00	.26	.07		
152	β Scorpil . . .	10	2.16	9.136	7.310	.09	.03	+ 1.34	
153	κ Herculis . . .	10	1.20	9.520	3.020	.13	.04	- .20	
154	ν Scorpil . . .	10	2.24	9.104	7.870	.11	.03		
155	σ Coronæ . . .	16	.85	9.660	2.190	.15	.03	+ .45	A, B. A, C.
156	" . . .	15	5.07	7.972	107.0	.43	.10	+ .63	
157	σ Scorpil . . .	10	5.44	7.824	150.0	.26	.07		
158	ν^2 Coronæ . . .	10	5.19	7.924	119.0	.37	.10		
159	η Draconis . . .	12	5.86	7.656	221.0	.24	.06		
160	17 Draconis . . .	10	-.11	0.044	.925	.16	.05	+ .11	A, B.
161	" . . .	10	1.06	9.576	2.650	.20	.06	- .06	A, C.
162	43 Herculis . . .	10	3.73	8.508	31.00	.24	.07	+ .27	A v. y. or go. Bin. 172°, 2".4. Bin. 210°, 5".
163	42 Herculis . . .	12	5.34	7.864	136.0	.25	.06	+ 1.36	
164	μ Draconis . . .	10	.09	9.964	1.090	.12	.03	- .09	
165	36 Ophiuchi . . .	10	.04	9.984	1.040	.08	.02		
166	α Herculis . . .	10	2.24	9.104	7.870	.23	.06	+ .86	
167	39 Ophiuchi . . .	10	1.51	9.396	4.020	.10	.03		Bin. 182°, 18".0.
168	δ Herculis . . .	10	5.44	7.824	150.0	.25	.07	- .34	
169	ν Serpentis . . .	10	4.52	8.192	64.30	.25	.07	- .02	
170	ρ Herculis . . .	10	.81	9.676	2.110	.09	.03	- .01	
171	ν Draconis . . .	12	-.04	0.016	.964	.12	.03	+ .14	
172	μ Herculis . . .	10	6.21	7.516	305.0	.33	.09	- .21	Bin. 310°, 3".6.
173	ψ Draconis . . .	10	1.18	9.528	2.960	.14	.04	+ .42	
174	67 Ophiuchi . . .	14	4.23	8.308	49.20	.28	.07	- .23	
175	95 Herculis . . .	10	.05	9.980	1.050	.12	.03	- .05	
176	70 P Ophiuchi . . .	11	1.70	9.320	4.790	.25	.07	+ .60	
177	μ Sagittarii . . .	10	5.70	7.720	191.0	.22	.06		Bin. 84°, 3".4. A, B. A, C.
178	" . . .	10	5.35	7.860	138.0	.15	.04		
179	η Serpentis . . .	10	7.46	7.016	964.0	.32	.09	+ 1.24	
180	21 Sagittarii . . .	11	2.52	8.992	10.20	.42	.11		
181	59 Serpentis . . .	10	2.10	9.160	6.920	.11	.03	+ .20	
182	39 Draconis . . .	10	2.66	8.936	11.60	.18	.05	+ .64	A, C.
183	" . . .	10	2.59	8.964	10.90	.32	.09	+ .71	A, C. Repeated.
184	" . . .	10	2.92	8.832	14.70	.18	.05	+ .28	A, B.
185	α Lyræ . . .	12	9.97	6.112	7730.	.23	.06	- .47	15 magn. Herschel. W. Equatorial. Bin. 16°, 3".0. Bin. 141°, 2".5.
186	110 Herculis . . .	10	8.91	6.436	3660.	.32	.09		
187	ϵ , 5 Lyræ . . .	11	-.05	0.020	.955	.27	.07		
188	ϵ Lyræ . . .	11	.96	9.616	2.420	.12	.03	+ .74	
189	5 Lyræ . . .	12	.23	9.908	1.240	.08	.02	+ .07	
190	ζ Lyræ . . .	13	1.38	9.448	3.560	.13	.03	- .28	W. Equatorial. First minimum. First maximum. Second minimum.
191	" . . .	2	1.46	9.416	3.840	.05	.04	- .36	
192	β Lyræ . . .	10	3.26	8.696	20.10	.09	.03	+ .44	
193	" . . .	10	3.89	8.444	36.00	.14	.04	- .19	
194	" . . .	10	3.42	8.632	23.30	.19	.05	+ .28	

No.	Name.	Σ	R.A., 1875.	Dec., 1875.	Date.	Angle.	Dist.	Color.		Magn.	
								A.	B.	A.	B.
195	β Lyræ	39 ^r	^{h.} 18 ^{m.} 45.4	[°] + 33 ['] 13	1835	[°] 149.8	["] 45.8	y.	w.	3.0	6.7
196	α Draconis . . .	2420	18 49.3	+ 59 15	1834	346.2	30.3	v. y.	ash.	4.3	7.5
197	θ Serpentis . . .	2417	18 50.2	+ 4 1	1830	103.8	21.6	y. w.	y. w.	4.5	4.6
198	η Lyræ	2487	19 9.6	+ 38 57	1831	85.0	27.9	bl.	ash.	4.0	8.3
199	"	"	"	"	"	"	"	"	"	"	"
200	"	"	"	"	"	"	"	"	"	"	"
201	"	"	"	"	"	"	"	"	"	"	"
202	β Cygni	43 ^r	19 25.7	+ 27 42	1832	55.7	34.3	y.	bl.	3.5	5.6
203	"	"	"	"	"	"	"	"	"	"	"
204	"	"	"	"	"	"	"	"	"	"	"
205	"	"	"	"	"	"	"	"	"	"	"
206	"	"	"	"	"	"	"	"	"	"	"
207	"	"	"	"	"	"	"	"	"	"	"
208	"	"	"	"	"	"	"	"	"	"	"
209	"	"	"	"	"	"	"	"	"	"	"
210	"	"	"	"	"	"	"	"	"	"	"
211	"	"	"	"	"	"	"	"	"	"	"
212	"	"	"	"	"	"	"	"	"	"	"
213	"	"	"	"	"	"	"	"	"	"	"
214	ϵ Sagittæ	Un.	19 31.6	+ 16 11	—	80.9	91.6	—	—	4.7	7.7
215	17 χ Cygni . . .	2580	19 41.5	+ 33 28	1833	73.4	25.7	v. y.	blsh.	5.0	8.2
216	ζ Sagittæ	2585	19 43.4	+ 18 50	1831	312.8	8.5	gr. w.	bl.	5.1	9.2
217	ϵ Draconis . . .	2603	19 48.5	+ 69 56	1832	354.5	2.8	y.	bl.	4.0	7.6
218	"	"	"	"	"	"	"	"	"	"	"
219	ψ Cygni	2605	19 52.4	+ 52 6	1831	184.6	3.3	w.	ash.	5.0	8.0
220	26 Cygni	Un.	19 57.8	+ 49 46	—	139.7	28.2	—	—	4.5	8.2
221	P.XX 63, α^2 Cygni	50 ^r	20 9.6	+ 46 22	1836	174.0	106.8	v. y.	bl.	3.7	6.5
222	κ Cephei	2675	20 13.2	+ 77 18	1832	124.1	7.4	gr. w.	bl.	4.2	8.2
223	β Capricorni . . .	52 ^r	20 13.7	- 15 11	1836	267.3	205.0	v. y.	bl.	2.5	6.0
224	β Delphini	2704	20 31.6	+ 14 9	1829	343.8	32.5	gr.	—	3.0	11.0
225	52 Cygni	2726	20 40.5	+ 30 14	1831	57.2	6.6	v. y.	—	4.3	9.4
226	γ Delphini	2727	20 41.1	+ 15 39	1831	273.8	11.9	go.	bl. gr.	4.0	5.0
227	f^1 Cygni	2743	20 55.5	+ 47 2	1832	352.4	20.2	gr. w.	bl.	4.7	9.0
228	61 Cygni	2758	21 0.9	+ 38 6	1829	89.4	15.3	y. or go.	y. or go.	5.1	6.0
229	δ Equulei	2777	21 8.4	+ 9 30	1833	38.8	27.4	v. y.	—	4.1	10.2
230	1 Pegasi	11 ^u	21 16.2	+ 19 15	1836	311.2	36.2	v. y.	—	4.3	9.2
231	β Cephei	2806	21 26.9	+ 70 00	1832	250.0	13.6	gr. w.	bl.	3.0	8.4
232	ϵ Pegasi	—	21 38.0	+ 9 18	—	324.3	138.	—	—	2.5	9.0
233	μ Cygni	2822	21 38.4	+ 28 12	1832	114.5	5.6	w.	bl. w.	4.6	6.0
234	κ Pegasi	2824	21 39.0	+ 25 5	1832	308.5	11.0	ysh.	—	3.9	10.8
235	ξ Cephei	2863	21 59.9	+ 64 0	1832	288.9	5.6	ysh.	bl.	4.6	6.6
236	ζ Aquarii	2909	22 22.3	- 0 40	1826	359.8	3.6	gr. w.	gr. w.	4.0	4.3
237	β Piscis Austrini .	—	22 24.4	- 32 59	—	173.	29.	—	—	4.0	8.0
238	δ Cephei	58 ^r	22 24.5	+ 57 46	1835	192.0	40.9	v. y.	bl.	3.0	5.3
239	ψ^1 Aquarii	12 ^u	23 9.3	- 9 46	1837	312.2	49.6	v. y.	bl.	4.2	9.0

TABLE V. — CATALOGUE OF BRIGHT DOUBLE STARS.

No.	Name.	No. of Sets.	Diff. in Magn.	Log.	Ratio.	Average Dev.	Prob. Error.	$\Sigma - O.$	Remarks.
195	β Lyrae	10	3.89	8.444	36.00	.14	.04	— .19	Second maximum.
196	α Draconis . . .	12	3.31	8.676	21.10	.27	.07	— .11	
197	θ Serpentis . . .	10	.87	9.652	2.230	.46	.13	— .77	
198	η Lyrae	12	3.80	8.480	33.10	.19	.05	+ .50	
199	"	10	4.07	8.372	42.50	.19	.05	+ .23	Repeated.
200	"	10	4.01	8.396	40.20	.23	.06	+ .29	Aperture 12.7 cms.
201	"	10	4.38	8.248	56.50	.48	.14	— .08	W. Equatorial.
202	β Cygni	12	2.14	9.144	7.180	.14	.04	— .04	
203	"	10	2.15	9.140	7.240	.21	.06	— .05	Repeated.
204	"	10	2.09	9.164	6.850	.10	.03	+ .01	Aperture 12.7 cms.
205	"	10	2.18	9.128	7.450	.15	.04	— .08	W. Equatorial.
206	"	2	2.54	8.984	10.40	.08	.07	— .44	Red glass.
207	"	2	1.94	9.224	5.970	.06	.05	+ .16	Blue glass.
208	"	5	2.22	9.112	7.730	.21	.09	— .12	Red images.
209	"	5	2.02	9.192	6.430	.12	.05	+ .08	Yellow images.
210	"	5	1.65	9.340	4.570	.11	.05	+ .45	Green images.
211	"	5	.93	9.628	2.350	.16	.07	+ 1.17	Blue images.
212	"	5	.63	9.748	1.790	.23	.10	+ 1.47	Indigo images.
213	"	2	.39	9.844	1.430	.13	.11	+ 1.71	Violet images.
214	ϵ Sagittae	10	3.10	8.760	17.40	.26	.07	— .10	
215	17 χ Cygni	10	3.50	8.600	25.10	.13	.04	— .30	
216	ζ Sagittae	10	3.67	8.532	29.40	.09	.03	+ .43	
217	ϵ Draconis	10	3.16	8.736	18.40	.21	.06	+ .44	
218	"	10	2.88	8.848	14.20	.15	.04	+ .72	Repeated.
219	ψ Cygni	14	2.50	9.000	10.00	.19	.04	+ .50	
220	26 Cygni	10	3.87	8.452	35.30	.15	.04	— .17	
221	P.XX 63, α^2 Cygni	10	3.15	8.740	18.20	.14	.04	— .35	
222	α Cephei	10	3.68	8.528	29.60	.12	.03	+ .32	
223	β Capricorni . . .	10	2.75	8.900	12.60	.31	.09	+ .75	W. Equatorial.
224	β Delphini	10	6.89	7.244	570.0	.36	.10	+ 1.11	
225	52 Cygni	11	4.79	8.084	82.40	.17	.05	+ .31	
226	γ Delphini	10	.99	9.604	2.490	.11	.03	+ .01	
227	f^1 Cygni	13	4.49	8.204	62.50	.20	.05	— .19	
228	61 Cygni	10	.80	9.680	2.090	.09	.03	+ .10	Bin. 119° 19".8.
229	δ Equulei	10	5.83	7.668	215.0	.17	.05	+ .27	
230	1 Pegasi	8	5.08	7.968	108.0	.14	.04	— .18	
231	β Cephei	10	4.45	8.220	60.30	.14	.04	+ .95	
232	ϵ Pegasi	10	5.88	7.648	225.0	.24	.07		W. Equatorial.
233	μ Cygni	13	1.49	9.404	3.940	.19	.05	— .09	
234	α Pegasi	12	5.72	7.712	194.0	.13	.03	+ 1.18	
235	ξ Cephei	10	1.97	9.212	6.140	.10	.03	+ .03	
236	ζ Aquarii	10	.18	9.928	1.180	.16	.05	+ .12	Bin. 334°, 3".4.
237	β Piscis Austrini .	10	3.50	8.600	25.10	.24	.07		Variable.
238	δ Cephei	10	2.47	9.012	9.730	.22	.06	— .17	
239	ψ^1 Aquarii	10	4.63	8.148	71.10	.14	.04	+ .17	

No satisfactory explanation has been found of the discrepancy between Nos. 1 and 2. It may be due to variability in the companion of α *Andromedæ*, or to a change in the instrument. When the difference in brightness of the components is greater than nine magnitudes, or the distance exceeds a minute of arc, satisfactory measurements are not to be expected with Photometer H. In the first case, the angle is too small to be measured with accuracy, and is affected too much by motion of the star in the field. When the components are distant, the four images must be placed in line, and the unequal distance from the bright star, of the images to be compared, becomes a source of error. This matter will be discussed later (page 171), and probably accounts for the discrepancy in the measurements of α *Leonis* (108 and 109) with the East and West Equatorial.

The observations of the variable star α *Ceti* (30 and 31), are introduced merely as an example of a method of studying the changes of this object. The observations of β *Lyræ* (192, 193, 194, and 195) were made within a few hours of its computed maxima and minima, and thus serve to show the range of variability of this star. Applying the slight correction needed to reduce the observations to the exact times of greatest and least light gives for the two minima 3.25 and 3.39, and for the maxima 3.90 and 3.89.

The accordance of these observations may be inferred from their average deviations from their mean value, or from the probable errors of the latter. The average deviation of a single set, including all the objects observed, is .192, and the probable error of the various results given in Table V. is .055. We may consider separately the stars observed with Photometer H with the unobstructed aperture of the large telescope. 208 series give an average deviation of .191, and a probable error of .052.

The effect of a variation of the distance of the components on the accordance of the measures is shown in the first four columns of Table VI. The stars are arranged in groups according to the distances of the components, the limits of each group being given in the first column. Thus the first line includes all stars whose distance lies between 0".0 and 2".9 inclusive; the second, all stars between 3".0 and 4".9, and so on. The second column gives the number of stars in each group; the third, the mean of their average deviations; and the fourth the average of the probable errors of their means.

The next four columns show in like manner the effect of a difference in the magnitudes of the two components. The first line includes all stars, the components of which differ by less than one magnitude; the second, those remaining in which the difference is less than two magnitudes, and so on. The last four columns group the stars according to the magnitude of the fainter component, as estimated by Struve. The first group contains all stars of which both components are brighter than the 4.9 magnitude inclusive.

TABLE VI.
ACCORDANCE OF RESULTS.

Distance.	No. of Stars.	Average Dev.	Prob. Error.	Diff. in Magn.	No. of Stars.	Average Dev.	Prob. Error.	Magn. by Σ .	No. of Stars.	Average Dev.	Prob. Error.
" "											
0.0 to 2.9	16	.214	.054	0.0 to .99	32	.137	.036	0.0 to 4.9	11	.173	.049
3.0 " 4.9	25	.179	.049	1.0 " 1.99	23	.143	.041	5.0 " 5.9	24	.130	.036
5.0 " 9.9	35	.159	.044	2.0 " 2.99	43	.169	.047	6.0 " 6.9	29	.168	.044
10.0 " 19.9	37	.158	.045	3.0 " 3.99	29	.184	.052	7.0 " 7.9	32	.188	.052
20.0 " 39.9	42	.189	.053	4.0 " 4.99	28	.222	.058	8.0 " 8.9	28	.178	.051
40.0 " 59.9	22	.214	.058	5.0 " 5.99	27	.228	.063	9.0 " 9.9	29	.198	.054
60.0 " 179.9	28	.248	.070	6.0 " 6.99	15	.219	.059	10.0 " 10.9	15	.232	.059
				7.0 " 8.99	6	.222	.075	11.0 " 12.0	8	.325	.089
				9.0 " 10.99	5	.470	.126				

In order to complete the observations during the year, many of them were made at a considerable distance from the meridian. The low altitude at which these stars were consequently observed does not seem to have lessened the accuracy of the measurements. The best evidence of this is given by the extreme southern stars, which were always observed near the horizon. The ten southernmost stars which have been measured are situated between $-22^{\circ} 29'$ and $-40^{\circ} 48'$. Their altitude at Cambridge never exceeds twenty-six degrees. The mean of their average deviations is only .13 of a magnitude. The results, therefore, agree even better than in the case of northern stars. The principal effect of the low altitude is to enlarge the disks of the stars. As it is easier to compare two luminous surfaces than two points of light, the increased accordance may be thus explained. It is also possible that the comparatively easy position of the observer in measuring stars near the horizon is favorable to the agreement of the results which he obtains.

When the components differ widely in color, considerable differences were anticipated in the measurements of different observers. This result has not been verified. The contrast in color is most marked in η *Cassiopeiae* (8), γ *Andromedæ* (21), and β *Cygni* (202, 203, 204, and 205). An examination of Table IV. shows that the results differ about as much for the same as for different observers. As it is not probable that all three observers have the same personal equation as regards color, we may infer that the errors from this cause will be small; or that, except perhaps in the case of very red stars, the color will cause but a slight error in the estimate of magnitude.

The errors discussed above are those in the mean of four settings. On the other hand, they include the systematic errors due to the varying conditions under which the different sets are taken. We must now determine the accordance of the consecutive settings of which each set is composed. For this purpose, and also to permit the application to these readings of any other test which may hereafter seem desirable,

the complete record of several measurements is given below. As the entire collection would be too voluminous, a number of stars have been selected as examples of the different classes of objects observed. Two of them, α *Ursæ Minoris* (12) and ζ *Ursæ Majoris* (131), were measured with especial care, to see if the accordance of the results could be thereby increased. The other stars were selected after the observations were completed, but without reference to the accordance of the results. They therefore represent average stars as nearly as possible. Two stars, 12 *Canum Venaticorum* (125) and η *Lyræ* (198) were chosen as samples of objects which could easily be measured, and in which the greatest accuracy was therefore to be expected. β *Cygni* (202) was added to represent the colored double stars. θ *Eridani* (42), the most southern object observed, serves to show the accuracy attained in measurements made near the horizon. ν *Draconis* (171) is given as a star the two components of which are nearly equal. Three stars, ϵ *Bootis* (139), 39 *Draconis* (182), and ϵ *Draconis* (217), represent the close doubles having components of unequal magnitude, which require good seeing for satisfactory measurement. α *Andromedæ* (1), α *Cassiopeïæ* (5), and α *Lyræ* (185) are stars the components of which differ very greatly in brightness. λ *Orionis* (72) was selected as affording an example of a very faint star. According to one of Struve's estimates, it is of the twelfth magnitude, the highest which occurs in his scale; and although he also regarded the companion of η *Serpentis* as of the twelfth magnitude, it seems to be in reality brighter than the faint companion of λ *Orionis*.

In each portion of Table VII., as in Table IV., the headings give the number and designation of the star; and the first three columns give the number of the set, its number in Table I., and the date. The next four columns give the individual readings. They are reduced by subtracting the first from the second and the third from the fourth. One fourth the sum of these differences is given in the next column headed "Reading," and the first difference *minus* the second is given in the tenth column headed "Diff." The ninth column gives the zero point, which equals the mean of the four readings, as in Table I. The eleventh column gives the observed difference in magnitude of the two components. It is found as in Table IV., by dividing the logarithm of the square of the cotangent of the reading by four-tenths.

The accordance of the individual settings may be tested in two ways. The differences given in the tenth column may be regarded as the sum of the errors of the second and fourth readings *minus* those of the first and third readings. Since a portion of these errors will cancel each other, we must divide the result by the square root of their number, or by two, to deduce the average deviation of a single setting from the mean.

This quantity may be reduced to magnitudes by the following method. Let v denote the difference between any given reading and the point at which the images

disappear; let m denote the corresponding difference in magnitudes. Then, as has been stated above,

$$m = \log \cot^2 v \div 0.4 = 5 \log \cot v.$$

Differentiating,

$$\frac{dm}{dv} = \frac{-5 \times .434}{\tan v \cos^2 v} = \frac{-5 \times .434}{\sin v \cos v} = \frac{-4.34}{\sin 2v},$$

in which dv is expressed in terms of the radius. Calling w the number of degrees corresponding to any arc v , we have $w = 57.3v$ and $dv = .01745dw$. Substituting this value in the above formula, $\frac{dm}{dw} = \frac{.076}{\sin 2v}$. This formula is exact only when the variation of the angle is very small. If the stars are equally bright, $v = 45^\circ$, and $\frac{dm}{dw} = .076$. Variations of 1° and 5° would by this formula show respectively differences in the magnitudes of .076, and .380. The true difference when the reading becomes 44° or 46° is .0758; it is .381 when v equals 40° or 50° . If $v = 10^\circ$, and $dw = 1^\circ$, the change in magnitude becomes .22. The true magnitudes are 4.00, 3.77, and 3.56, or the changes in magnitude .23 and .21. The error in using this formula is therefore quite inappreciable when the variation of the angle is not large.

Column twelve, headed "Resid. Diff.," gives the average deviations of a single setting deduced by this method. The next column gives the same quantity determined by a direct comparison of each reading with that derived from the mean of each set, and reduced from degrees to magnitudes by the formula given above. When the difference in light of the two stars is very great, or the angle designated as the reading is very small, this method of reduction gives erroneous results, owing to the change of the zero in different parts of the field. In some cases, where the star has moved between the second and third settings, the values of the reading became negative, or the deviation was greater than would be required to produce an infinite error. This column is therefore left blank in the case of α *Andromedæ*, α *Cassiopeïæ*, λ *Orionis*, and α *Lyrcæ*. The last two columns give the deviations of each set from the mean, and the initial of the observer as in Table IV.

TABLE VII.

DETAILS OF OBSERVATIONS.

No.	No. in Table I.	Date.	Readings.				Reading.	Zero.	Diff.	Diff. in Magn.	Resid. Diff.	Resid. one Setting.	Resid. one Set.	Obs.
			A.	B.	C.	D.								
1. α ANDROMEDÆ. Σ 13. (1878.)														
1	1239	Jan. 3	33.7	36.3	212.2	214.8	1.30	124.25	.0	8.22	.00		-.05	P.
2	1241	" "	123.8	126.3	302.2	304.6	1.22	214.23	+.1	8.35	.09		+.08	P.
3	1242	" "	123.9	126.4	302.5	304.4	1.10	214.30	+.6	8.08	.53		-.19	S.
4	1243	" "	34.0	36.6	212.0	214.5	1.27	124.27	+.1	8.26	.09		-.01	S.
5	1265	Jan. 5	34.2	36.8	211.7	213.9	1.20	124.15	+.4	8.39	.35		+.12	S.
6	1266	" "	123.4	126.0	303.4	305.8	1.25	214.65	+.2	8.31	.18		+.04	S.
7	1267	" "	123.4	125.6	303.0	305.4	1.15	214.35	-.2	8.49	.18		+.22	P.
8	1268	" "	32.2	34.7	214.4	216.6	1.17	124.48	+.3	8.44	.26		+.17	P.
9	1358	Jan. 16	125.2	128.4	306.3	308.7	1.40	217.15	+.8	8.06	.70		-.21	P.
10	1359	" "	34.9	37.3	216.7	219.7	1.35	127.15	-.6	8.14	.53		-.13	P.
										8.27	.29		$\pm .12$	
5. α CASSIOPELÆ. Σ Un. (1878.)														
1	1247	Jan. 3	30.2	36.1	212.3	217.9	2.87	124.12	+.3	6.50	.12		-.12	P.
2	1248	" "	121.3	126.9	300.9	305.9	2.65	213.75	+.6	6.67	.24		+.07	P.
3	1438	Jan. 22	33.6	39.2	214.0	219.2	2.70	126.50	+.4	6.63	.16		+.01	S.
4	1439	" "	124.7	129.2	304.5	309.0	2.25	216.85	.0	7.03	.00		+.41	S.
5	1446	Jan. 24	124.2	129.6	304.6	309.3	2.52	216.92	+.7	6.78	.28		+.16	P.
6	1447	" "	33.4	39.2	214.8	219.9	2.72	126.82	+.7	6.61	.28		-.01	P.
7	1456	" "	33.0	38.5	215.3	221.1	2.82	126.97	-.3	6.54	.12		-.08	S.
8	1457	" "	122.5	129.4	305.0	310.6	3.12	216.87	+1.3	6.31	.52		-.31	S.
9	1668	Feb. 6	133.0	139.3	315.4	321.2	3.02	227.21	+.5	6.38	.20		-.24	S.
10	1669	" "	44.0	48.8	225.8	231.0	2.50	137.40	-.4	6.80	.16		+.18	S.
11	1670	" "	44.5	50.0	224.0	229.8	2.82	137.07	-.3	6.54	.12		-.08	U.
12	1671	" "	135.3	140.5	313.0	318.4	2.65	226.80	-.2	6.67	.08		+.05	U.
										6.62	.19		$\pm .14$	
12. α URSÆ MINORIS. Σ 93. (1877-78.)														
1	1088	Dec. 25	24.0	28.9	204.3	210.0	2.65	116.80	-.8	6.67	.31	.27	+.10	P.
2	1089	" "	23.6	28.8	204.4	210.6	2.85	116.85	-1.0	6.51	.39	.51	-.06	P.
3	1090	" "	113.9	120.3	293.8	299.4	3.00	206.85	+.8	6.40	.31	.17	-.17	P.
4	1091	" "	113.8	119.4	294.6	300.4	2.85	207.05	-.2	6.52	.08	.35	-.05	P.
5	1218	Jan. 1	23.6	28.4	204.3	209.5	2.50	116.45	-.4	6.80	.16	.35	+.23	P.
6	1219	" "	24.4	29.4	204.7	210.0	2.57	117.12	-.3	6.74	.12	.17	+.17	S.
7	1220	" "	113.9	119.5	295.4	300.2	2.60	207.25	+.8	6.71	.31	.43	+.14	P.
8	1221	" "	114.8	120.3	294.1	300.0	2.85	207.30	-.4	6.52	.16	.19	-.05	S.
9	1323	Jan. 13	34.2	40.1	213.5	219.6	3.00	126.85	-.2	6.40	.08	.23	-.17	P.
10	1324	" "	34.1	40.2	213.1	219.2	3.05	176.65	.0	6.37	.00	.39	-.20	S.
11	1325	" "	124.6	130.1	303.2	308.6	2.72	216.62	+.1	6.61	.04	.56	+.04	P.
12	1326	" "	125.0	130.9	303.4	308.6	2.79	216.99	+.7	6.56	.25	.77	-.01	S.
										6.57	.18	.37	$\pm .12$	

TABLE VII. — DETAILS OF OBSERVATIONS.

No.	No. in Table I.	Date.	Readings.				Read- ing.	Zero.	Diff.	Diff. in Magn.	Resid. Diff.	Resid. one Setting.	Resid. one Set.	Obs.
			A.	B.	C.	D.								
42. θ ERIDANI. (1878.)														
1	1557	Feb. 2	17.3	77.4	190.8	256.3	31.4	135.4	- 5.4	1.07	.23	.16	- .02	P.
2	1583	Feb. 3	139.4	199.4	320.2	20.2	30.0	169.8	.0	1.19	.00	.03	+ .10	P.
3	1584	" "	138.6	202.4	318.0	24.1	32.5	170.8	- 2.3	.98	.10	.05	- .11	S.
4	1585	" "	43.0	111.8	227.1	292.6	33.6	168.6	+ 3.3	.89	.14	.10	- .20	P.
5	1586	" "	48.5	110.6	233.7	290.1	29.6	170.7	+ 5.7	1.23	.24	.13	+ .14	S.
6	1611	Feb. 4	139.4	194.3	315.2	18.4	29.5	166.8	- 8.3	1.24	.36	.18	+ .15	P.
7	1612	" "	135.1	203.9	314.2	23.0	34.4	169.0	.0	.82	.00	.04	- .27	S.
8	1613	" "	41.8	107.0	224.6	286.6	31.8	165.0	+ 3.2	1.04	.14	.07	- .05	P.
9	1614	" "	48.8	107.8	231.4	288.3	29.0	169.1	+ 2.1	1.28	.09	.07	+ .19	S.
10	1634	Feb. 5	17.0	79.1	198.2	259.1	30.7	138.4	+ 1.2	1.13	.05	.06	+ .04	P.
11	1635	" "	106.8	169.6	288.4	347.6	30.5	228.1	+ 3.6	1.15	.15	.08	+ .06	P.
										1.09	.14	.09	$\pm$.12	
72. λ ORIONIS A, C. Σ 738. (1878.)														
1	2243	Mar. 20	149.4	153.6	332.9	336.4	1.92	243.07	+ .7	7.37	.36		+ .20	U.
2	2244	" "	61.4	64.8	240.8	245.7	2.07	153.17	- 1.5	7.20	.78		+ .03	U.
3	2245	" "	60.6	64.1	241.6	246.2	2.02	153.12	- 1.1	7.26	.57		+ .09	P.
4	2246	" "	150.4	154.9	332.2	336.7	2.25	243.55	.0	7.03	.00		- .14	P.
5	2277	Mar. 22	152.4	157.1	335.3	340.8	2.55	246.40	- .8	6.76	.42		- .41	P.
6	2278	" "	64.3	68.6	244.2	249.3	2.35	156.60	- .8	6.93	.42		- .24	P.
7	2279	" "	60.2	64.1	241.0	244.9	1.95	152.55	.0	7.34	.00		+ .17	U.
8	2280	" "	149.0	152.3	331.2	335.0	1.77	241.87	- .5	7.54	.26		+ .37	U.
9	2342	Mar. 30	149.9	153.3	332.3	336.4	1.87	242.97	- .7	7.43	.36		+ .26	P.
10	2343	" "	60.8	65.3	239.9	244.7	2.32	152.67	- .3	6.96	.16		- .21	P.
11	2344	" "	60.5	64.7	241.1	245.8	2.22	153.02	- .5	7.05	.26		- .12	S.
12	2345	" "	149.5	154.1	332.0	335.9	2.12	242.87	+ .7	7.15	.36		- .02	S.
										7.17	.33		$\pm$.19	
125. 12 CANUM VENAT. Σ 1692. (1878.)														
1	2112	Mar. 10	56.3	86.4	236.1	267.4	15.3	161.6	- 1.2	2.81	.08	.04	+ .18	P.
2	2113	" "	145.0	176.3	326.8	357.8	15.6	251.5	+ .3	2.77	.02	.11	+ .14	P.
3	2134	Mar. 15	54.4	88.5	233.1	268.6	17.4	161.2	- 1.4	2.52	.10	.05	- .11	P.
4	2135	" "	139.8	177.1	322.0	359.0	18.6	249.5	+ .3	2.37	.02	.14	- .26	P.
5	2136	" "	143.4	179.3	323.1	358.8	17.9	251.2	+ .2	2.45	.01	.03	- .18	U.
6	2137	" "	52.2	86.9	231.9	266.9	17.4	159.5	- .3	2.52	.02	.01	- .11	U.
7	2549	May 4	32.6	62.8	214.3	243.4	14.8	138.3	+ 1.1	2.89	.08	.08	+ .26	P.
8	2550	" "	120.6	156.1	302.2	338.6	18.0	229.4	- .9	2.44	.06	.14	- .19	P.
9	2551	" "	122.1	154.0	305.0	334.6	15.4	228.9	+ 2.3	2.80	.16	.12	+ .17	S.
10	2552	" "	32.9	65.5	212.0	243.0	15.9	138.4	+ 1.6	2.73	.11	.12	+ .10	S.
										2.63	.07	.08	$\pm$.17	
131. ζ URSÆ MAJORIS. Σ 1744. (1878.)														
1	2114	Mar. 10	138.5	185.3	314.4	4.4	24.2	160.6	- 3.2	1.74	.15	.12	+ .18	P.
2	2115	" "	45.2	92.6	226.9	274.5	23.7	159.8	- .2	1.79	.01	.09	+ .23	P.
3	2138	Mar. 15	45.4	97.1	227.8	278.2	25.5	162.1	+ 1.3	1.61	.06	.08	+ .05	P.
4	2139	" "	137.4	183.6	318.8	363.9	22.8	250.9	+ 1.1	1.88	.05	.04	+ .32	P.
5	2140	" "	134.3	188.8	315.0	366.2	26.4	251.1	+ 3.3	1.52	.16	.08	- .04	U.
6	2141	" "	43.1	97.8	225.4	279.5	27.2	161.4	+ .6	1.44	.03	.10	- .12	U.
7	2502	May 1	108.3	161.3	286.2	344.7	27.9	225.1	- 5.5	1.38	.26	.13	- .18	S.
8	2503	" "	19.3	70.3	204.2	255.0	25.4	137.2	+ .2	1.62	.01	.23	+ .06	S.
9	2504	" "	19.1	77.2	199.9	261.0	29.8	139.3	- 3.0	1.21	.14	.11	- .35	U.
10	2505	" "	110.9	165.6	289.9	344.2	27.2	227.6	+ .4	1.45	.02	.06	- .11	U.
										1.56	.09	.10	$\pm$.16	

No.	No. in Table I.	Date.	Readings.				Reading.	Zero.	Diff.	Diff. in Magn.	Resid. Diff.	Resid. one Setting.	Resid. one Set.	Obs.
			A.	B.	C.	D.								
139. ϵ Bootis. Σ 1877. (1878.)														
1	2396	Apr. 8	52.2	82.3	233.2	263.7	15.1	157.8	— .4	2.59	.03	.08	+.18	S.
2	2397	“ “	141.9	171.2	323.2	358.9	16.2	248.8	— 6.4	2.69	.41	.29	+.28	S.
3	2699	May 21	121.8	158.6	301.4	338.5	18.5	230.1	— .3	2.38	.02	.02	— .03	U.
4	2770	June 3	31.1	76.0	213.0	251.1	20.7	142.8	+ 6.8	2.11	.44	.22	— .30	S.
5	2771	“ “	34.4	73.8	211.0	259.8	22.0	144.8	— 9.4	1.97	.60	.30	— .44	P.
6	2772	“ “	118.0	161.0	301.9	340.8	20.5	230.4	+ 4.1	2.14	.26	.13	— .27	S.
7	2773	“ “	123.2	161.8	304.8	338.2	18.0	232.0	+ 5.2	2.44	.33	.17	+ .03	P.
8	2786	June 5	37.3	71.0	215.6	251.1	17.3	143.8	— 1.8	2.53	.12	.06	+ .12	U.
9	2787	“ “	125.5	158.3	306.4	341.7	17.0	233.0	— 2.5	2.57	.16	.14	+ .16	U.
10	2788	“ “	36.2	71.5	214.7	251.3	18.0	143.4	— 1.3	2.44	.08	.05	+ .03	P.
11	2789	“ “	127.8	162.1	309.4	340.1	16.2	234.8	+ 3.6	2.68	.23	.12	+ .27	P.
										2.41	.24	.14	$\pm .19$	
171. ν Draconis. Σ 351. (1878.)														
1	2665	May 17	90.5	186.5	271.5	9.2	48.4	139.4	— 1.7	— .26	.06	.07	— .22	S.
2	2666	“ “	0.0	97.2	177.6	273.8	48.4	137.2	+ 1.0	— .26	.04	.11	— .22	S.
3	2741	May 26	2.1	88.8	181.8	271.0	44.0	135.9	— 2.5	.08	.09	.05	+ .11	P.
4	2742	“ “	2.2	94.4	180.8	272.2	45.9	137.4	+ .8	— .07	.03	.07	— .03	S.
5	2743	“ “	91.5	178.7	270.2	358.8	43.9	224.8	— 1.4	.08	.05	.03	+ .12	S.
6	2744	“ “	90.2	181.0	269.1	0.1	45.5	135.1	— .2	— .04	.01	.04	.00	P.
7	2754	May 29	93.0	185.8	276.8	8.0	46.0	140.9	+ 1.6	— .08	.06	.11	— .03	S.
8	2755	“ “	2.9	93.0	185.6	278.8	45.8	140.1	— 3.1	— .06	.12	.16	— .02	S.
9	2756	“ “	4.8	84.9	188.0	273.0	41.3	137.7	— 4.9	.28	.19	.21	+ .32	U.
10	2757	“ “	92.5	179.4	275.2	4.1	43.9	137.8	— 2.0	.08	.08	.14	+ .12	U.
11	2812	June 6	180.1	272.3	359.8	89.0	45.3	225.3	+ 3.0	— .02	.11	.07	+ .02	P.
12	2813	“ “	90.7	185.8	270.3	6.6	47.9	138.4	— 1.2	— .22	.05	.02	— .18	P.
										— .04	.07	.09	$\pm .12$	
182. 39 Draconis A, C. Σ 2323. (1877.)														
1	747	Dec. 3	138.2	165.4	311.2	340.7	14.2	238.9	— 2.3	2.98	.16	.41	+ .32	P.
2	748	“ “	135.0	165.8	309.3	345.2	16.7	238.8	— 5.1	2.61	.36	.22	— .05	S.
3	934	Dec. 16	102.2	132.0	283.2	309.6	14.0	206.8	+ 3.4	3.01	.24	.12	+ .35	P.
4	935	“ “	100.7	133.2	280.7	311.4	15.8	206.5	+ 1.8	2.74	.13	.06	+ .08	P.
5	936	“ “	100.1	133.0	278.3	313.8	17.1	206.3	— 2.6	2.56	.18	.09	— .10	S.
6	937	“ “	100.0	139.0	274.8	317.3	20.4	207.8	— 3.5	2.15	.24	.24	— .51	S.
7	977	Dec. 18	142.1	173.1	321.7	355.2	16.1	248.0	— 2.5	2.70	.18	.09	+ .04	S.
8	978	“ “	137.6	175.2	321.5	355.6	17.9	247.5	+ 3.5	2.45	.24	.15	— .21	P.
9	979	“ “	140.6	172.6	321.8	356.0	16.5	247.8	— 2.2	2.64	.15	.16	— .02	S.
10	980	“ “	141.6	170.0	319.9	354.6	15.8	246.5	— 6.3	2.74	.44	.22	+ .08	P.
										2.66	.23	.18	$\pm .18$	
185. α Lyrae. Σ 911. (1877.)														
1	1144	Dec. 27	26.9	28.4	205.0	206.3	.70	116.6	+ .2	9.56	.37		— .41	P.
2	1145	“ “	27.5	28.9	204.8	205.8	.60	116.8	+ .4	9.90	.74		— .07	S.
3	1146	“ “	116.8	115.6	296.6	297.4	.50	206.6	+ .4	10.29	.74		+ .32	P.
4	1147	“ “	116.1	117.2	296.1	297.2	.55	206.6	.0	10.10	.00		+ .13	S.
5	1180	Dec. 28	24.6	25.8	207.6	208.8	.60	116.7	.0	9.90	.00		— .07	P.
6	1181	“ “	24.4	26.1	207.3	208.5	.72	116.6	+ .5	9.49	.93		— .48	S.
7	1182	“ “	115.4	116.7	296.8	297.6	.50	206.6	+ .5	10.29	.93		+ .32	P.
8	1183	“ “	116.0	117.5	296.6	297.4	.50	206.9	+ .7	10.29	1.30		+ .32	S.

TABLE VII. — DETAILS OF OBSERVATIONS.

No.	No. in Table I.	Date.	Readings.				Read- ing.	Zero.	Diff.	Diff. in Magn.	Resid. Diff.	Resid. one Setting.	Resid. one Set.	Obs.
			A.	B.	C.	D.								
185. α Lyræ. Σ 9 ^u (continued).														
9	1209	Dec. 29	27.9	29.2	205.0	206.4	.67	117.1	— .1	9.64	.19		— .33	P.
10	1210	" "	28.0	29.0	205.2	206.5	.57	117.2	— .3	9.99	.56		+ .02	S.
11	1211	" "	117.5	118.4	295.9	297.3	.57	207.3	— .5	9.99	.93		+ .02	P.
12	1212	" "	117.1	117.9	296.5	297.8	.52	207.3	— .5	10.19	.93		+ .22	S.
										9.97	.64		± .23	
198. η Lyræ. Σ 2487. (1877.)														
1	793	Dec. 7	149.8	171.5	330.0	353.2	11.22	251.1	— 1.5	3.51	.17	.11	— .29	S.
2	794	" "	150.7	170.2	331.7	352.7	10.12	251.3	— 1.5	3.74	.17	.19	— .06	U.
3	795	" "	150.5	171.4	330.5	353.5	10.97	251.5	— 2.1	3.56	.24	.12	— .24	U.
4	796	" "	147.9	173.8	331.9	354.6	12.15	252.0	+ 3.2	3.33	.36	.27	— .47	S.
5	874	Dec. 14	176.8	195.8	356.9	15.1	9.30	186.2	+ .8	3.93	.09	.04	+ .13	P.
6	875	" "	175.0	194.6	356.6	15.8	9.70	185.5	+ .4	3.84	.04	.16	+ .04	S.
7	876	" "	175.9	197.3	354.6	14.3	10.28	185.5	+ 1.7	3.71	.19	.24	— .09	P.
8	877	" "	177.7	195.8	357.0	15.2	9.08	186.4	— .1	3.98	.01	.07	+ .18	S.
9	930	Dec. 16	18.1	35.6	198.6	215.4	8.57	116.9	+ .7	4.11	.08	.04	+ .31	P.
10	931	" "	18.3	35.6	197.9	216.1	8.87	117.0	— .9	4.03	.10	.05	+ .23	P.
11	932	" "	15.2	35.1	197.9	216.7	9.67	116.2	+ 1.1	3.84	.12	.24	+ .04	S.
12	933	" "	17.6	34.9	198.2	216.0	8.77	116.7	— .5	4.05	.06	.09	+ .25	S.
										3.80	.14	.14	± .19	
202. β Cygni. Σ 431. (1877.)														
1	806	Dec. 8	141.3	181.3	320.8	3.8	20.7	161.8	— 3.0	2.11	.17	.08	— .03	S.
2	807	" "	136.8	181.3	320.1	6.4	22.7	161.2	— 1.8	1.89	.10	.24	— .25	P.
3	808	" "	142.4	186.8	322.0	4.8	21.8	164.0	+ 1.6	1.99	.09	.07	— .15	S.
4	809	" "	144.4	182.8	327.2	4.8	19.0	324.4	+ .8	2.31	.05	.14	+ .17	U.
5	810	" "	143.2	182.5	324.4	6.5	20.3	164.2	— 2.8	2.16	.16	.15	+ .02	U.
6	811	" "	140.1	186.8	318.0	6.2	23.7	162.8	— 1.5	1.79	.09	.08	— .35	P.
7	981	Dec. 18	48.8	88.8	228.3	268.9	20.1	158.7	— .6	2.18	.03	.02	+ .04	P.
8	982	" "	49.8	87.1	229.0	267.2	18.9	158.3	— .9	2.33	.05	.03	+ .19	S.
9	983	" "	49.1	88.1	234.2	266.2	17.7	159.4	+ 7.0	2.48	.41	.20	+ .34	P.
10	984	" "	49.8	87.9	227.8	270.0	20.1	158.9	— 4.1	2.18	.24	.12	+ .04	S.
11	1007	Dec. 22	146.6	186.9	326.4	7.0	20.2	166.7	— .3	2.17	.02	.01	+ .03	P.
12	1008	" "	147.4	188.6	323.0	4.4	20.6	165.8	— .2	2.12	.01	.25	— .02	P.
										2.14	.12	.12	± .14	
217. ε Draconis. Σ 2603. (1877-78.)														
1	1001	Dec. 20	60.7	82.9	241.5	264.9	11.4	162.5	— 1.2	3.48	.10	.12	+ .32	S.
2	1002	" "	61.2	83.6	240.2	265.6	11.9	162.6	— 3.0	3.38	.26	.13	+ .22	S.
3	1138	Dec. 26	99.8	129.1	283.7	308.8	13.6	205.4	+ 4.2	3.08	.36	.19	— .08	P.
4	1139	" "	100.6	131.5	282.8	311.5	14.9	206.6	+ 2.2	2.87	.19	.09	— .29	S.
5	1140	" "	14.5	38.5	194.5	218.6	12.0	116.5	— .1	3.36	.01	.00	+ .20	P.
6	1141	" "	12.2	38.1	194.1	220.2	13.0	116.2	— .2	3.24	.02	.17	+ .08	S.
7	1282	Jan. 9	111.2	137.2	290.0	315.0	12.7	213.4	+ 1.0	3.23	.09	.15	+ .07	S.
8	1283	" "	17.5	50.6	198.4	232.2	16.7	124.7	— .7	2.62	.06	.12	— .54	S.
9	1321	Jan. 13	24.9	48.3	203.3	229.4	12.4	126.5	— 2.7	3.39	.23	.12	+ .23	P.
10	1322	" "	109.9	138.0	292.1	321.6	14.4	215.4	— 1.4	2.95	.12	.25	— .21	P.
										3.16	.14	.13	± .21	

Set 12 of α *Ursæ Minoris* (1326) contains five readings. Owing to clouds, the last reading of 308.4 was repeated, with a result of 308.9. The mean 308.6 is inserted as the reading, while the other columns are reduced from the mean carried to hundredths, or 308.65. In like manner, set 5 of ϵ *Bootis* (2771) consisted of five readings, two of which, 212.4 and 209.6, were replaced by their mean 211.0. Sets 7 and 8 of α *Lyræ* consist of six readings each. In set 7, 296.8 is substituted for 297.2 and 296.4; and 297.6 for 297.9 and 297.4. In set 8, 297.0 and 296.2 are replaced by 296.6; and 297.6 and 297.1 by 297.4.

The mean values found in Table VII. are compared in Table VIII. The successive columns give a current number, the number in Table V., the name, the number of sets, the observed difference in magnitude, the three measures of the average deviation obtained in Table VII., and remarks.

Lines 15, 16, and 17 classify these stars by combining the results obtained for those the components of which are of very unequal brightness, those in which the interval between the components is small, and those not included in either of the groups just named. The result deduced from all the stars occupies the last line.

TABLE VIII.

SUMMARY OF TABLE VII.

No.	No. in Table V.	Name.	No.	Diff. in Magn.	Average Deviation.			Remarks.
					Diff.	One Setting.	One Set.	
1	1	α Andromedæ . .	10	8.27	.29	—	.12	Unequal. A 2.0, B 11.1.
2	5	α Cassiopeiæ . .	12	6.62	.19	—	.14	Unequal. A 2.5, B 10.0.
3	12	α Ursæ Minoris .	12	6.57	.18	.37	.12	Unequal. A 2.0, B 9.0.
4	42	θ Eridani . . .	11	1.09	.14	.09	.12	Southern Star, Decl. $-40^{\circ} 48'$.
5	72	λ Orionis A, C . .	12	7.17	.33	—	.19	Companion faint. A 4.2, C 11.2.
6	125	12 Canum Venat. .	10	2.63	.07	.08	.17	Components bright.
7	131	ζ Ursæ Majoris .	10	1.56	.09	.10	.16	" "
8	139	ϵ Bootis	11	2.41	.24	.13	.19	Close. Distance $2''.6$.
9	171	ν Draconis . . .	12	— .04	.07	.09	.12	Components equal.
10	182	39 Draconis A, C .	10	2.66	.20	.18	.18	Close. Distance $3''.1$.
11	185	α Lyræ	12	9.98	.62	—	.23	Unequal. A 1.0, B 10.5.
12	198	η Lyræ	12	3.80	.14	.14	.19	Components bright.
13	202	β Cygni	12	2.14	.12	.12	.14	Components colored. A y. B bl.
14	217	ϵ Draconis . . .	10	3.16	.14	.13	.21	Close. Distance $2''.8$.
15	—	Unequal	58	—	.32	—	.16	Nos. 1, 2, 3, 5, 11.
16	—	Close	31	—	.19	.15	.12	Nos. 8, 10, 14.
17	—	Bright	67	—	.10	.10	.15	Nos. 4, 6, 7, 9, 12, 13.
18	—	All	156	—	.20	.14	.16	Nos. 1 to 14 inclusive.

As these average deviations are derived from groups composed of different numbers of separate results, they cannot be compared directly as tests of accordance. When a group is small, the mean is likely to agree more nearly with the separate re-

sults than is the case with the true value. This error is corrected by the factor $\sqrt{\frac{n}{n-1}}$ in the formula for the probable error $E = .845 \sqrt{\frac{n}{n-1}} A$, in which n is the number of separate results, and A the average deviation. In the first of the methods used above to determine the average deviation of one setting, an error in the mean is eliminated, so that this correction need not be applied. The probable error of a single setting is therefore deduced from the sixth column by multiplying by .845. The values in the seventh column are deduced from four readings each. Since in this case $n = 4$, we must multiply the results by $.845 \sqrt{\frac{4}{3}} = .98$. In the eighth column the average deviation is deduced from ten to twelve separate results. The probable error is therefore derived by multiplying the average deviation by .89. The values of the probable errors of the close stars by the methods of the sixth and seventh columns become therefore .16 and .15; those of the bright stars become .08 and .10. The two methods therefore give sensibly the same result, when the components are not very unequal. The corresponding probable errors of one set are .11 and .13. It therefore appears that the accordance of the separate settings is as great as that of the sets of four settings taken at different times by different observers. In other words, according to the theory of probabilities, three-fourths of the errors are due to variations of the object, the air, the instrument, and the observer, and one-fourth to errors of observations properly so called.

It will be noticed that the observations of α *Ursæ Minoris* and of ζ *Ursæ Majoris* are not more accordant than the others, although, as has been stated above, especial care was taken in the measurement of these stars. From this we may conclude that the remaining errors are beyond the control of the observer, so that very little would be gained by spending more time and care on each setting.

One of the best tests of the accuracy of a series of measurements consists in the repetition of a portion of them and a comparison of the results with those previously obtained. Accordingly, when the above measurements were nearly completed, ten of the stars selected for Table VII. were reobserved: α *Andromedæ*, α *Cassiopeiæ*, and α *Ursæ Minoris* represent the stars differing widely in brightness; ϵ *Bootis*, 39 *Draconis*, and ϵ *Draconis*, the close doubles; β *Cygni* the colored stars; and 12 *Canum Venaticorum*, ζ *Ursæ Majoris*, and η *Lyrae* the bright and easily measured pairs. The last four stars may be observed with a smaller instrument; they were therefore again measured with the East Equatorial, reducing the aperture to 12.7 cms., and also with the West Equatorial.

At one time it was proposed to repeat the observation of all stars of which the average deviation of the individual sets exceeded two-tenths of a magnitude. This was soon given up for two reasons. First, the delay required for the reduction ren-

dered it necessary to observe the stars in the evening twilight near the western horizon, and sometimes would make it impossible to complete the measurement until the next year. Secondly, discordance in the sets does not necessarily imply bad readings, but may be due to chance in the distribution of the accidental errors. Three stars, η *Tauri*, β *Orionis*, and δ *Orionis*, were, however, repeated before this plan was abandoned.

Table IX. gives a summary of these measurements. The current number and the numbers of the series in Table V. are given in the first three columns. These are followed by the name of the star, the observed differences of magnitude, taken from Table V., and their difference. The next three columns give the average deviations and their difference. The last column shows to what class the star belongs, and in which sets the aperture was reduced. In these sets the first observation was made with the East, the second with the West Equatorial.

TABLE IX.

REPEATED STARS.

No.	Nos. in Table V.		Name.	Differences in Magnitude.		Diff.	Average Deviation.		Diff.	Remarks.
1	1	2	α Andromedæ .	8.32	9.81	[−1.49]	.13	[.81]	[+.68]	Faint.
2	5	6	α Cassiopeiæ . .	6.62	6.46	+.16	.14	.25	−.11	"
3	12	13	α Ursæ Minoris .	6.57	6.67	−.10	.12	.19	−.07	"
4	139	140	ε Bootis . . .	2.41	2.44	−.03	.19	.19	.00	Close.
5	182	183	β Draconis . . .	2.66	2.59	+.07	.18	.32	−.14	"
6	217	218	ε Draconis . . .	3.16	2.88	+.28	.21	.15	+.06	"
7	202	203	β Cygni . . .	2.14	2.15	−.01	.14	.21	−.07	Colored.
8	204	205	" . . .	2.09	2.18	−.09	.10	.15	−.05	" Ap. 12.7 cms.
9	125	126	12 Canum Venat.	2.63	2.63	.00	.17	.12	+.05	Bright.
10	127	128	" "	2.59	2.40	+.19	.15	.17	−.02	" Ap. 12.7 cms.
11	131	132	ζ Ursæ Majoris .	1.56	1.66	−.10	.16	.11	+.05	"
12	133	134	" "	1.71	1.59	+.12	.11	.16	−.05	" Ap. 12.7 cms.
13	198	199	η Lyræ . . .	3.80	4.07	−.27	.19	.19	.00	"
14	200	201	" . . .	4.01	4.38	−.37	.23	.48	−.25	" Ap. 12.7 cms.
15	46	47	η Tauri . . .	3.25	3.29	−.04	.26	.23	+.03	"
16	66	67	β Orionis . . .	6.25	6.29	−.04	.27	.17	+.10	"
17	69	70	δ Orionis . . .	4.35	4.40	−.05	.46	.17	+.29	"

For reasons already given (page 154), the observations of α *Andromedæ* are doubtful. The second series makes the difference in the brightness of the components so great that they cannot be measured with accuracy. Excluding the observations of this star, and also those made with the smaller aperture, twelve objects remain, of which the second reading differs from the first on the average a little less than a tenth of a magnitude. The mean results in 1878 do not differ sensibly from those in 1877. The average deviations are also nearly the same, although many thousand measurements

had been made during the interval by the same persons. This confirms the suggestion already made, that the remaining errors are in a great measure out of the control of the observer.

An independent determination of the accuracy of these measurements has been made by comparing the two images of the same star. This method possesses two advantages over the preceding. First, since both images are seen through the same layer of air, variation in the density of the latter will affect both equally. Secondly, were there no errors, the two images would in every case be exactly equal in brightness, while in the previous discussion we have had to assume the mean as the true value. To distinguish the two images, that in which the plane of polarization passes through both images will be designated as A, and the other image as B. Their directions will be denoted by the apparent position angle of B from A, always counted from the lowest part of the field. For example, the angle 90° denotes that the images were parallel to the line connecting the eyes, and that the right-hand image was polarized in a vertical plane, the other horizontally.

A complete series of measurements was made by each observer, to determine his individual peculiarities. All the readings were made with the index designated in the last column of Table I. as Index O.

The effect of a variation in the distance of the two images to be compared is shown in Table X. The telescope was turned upon λ *Ursæ Minoris*, and the two images of this star were separated to their greatest interval of $60''$. A set of four readings was then taken, and this was repeated with intervals between the images of $20''$, $10''$, $5''$, and $3''$, these distances being estimated by the eye. The apparent position angle was 90° in all cases. These observations are given in Table I., Nos. 3425-3434, 3518-3522.

In Table X. the first column gives the distance between the images, and the other columns are arranged in three sets of four each. The first set gives the average deviations of the individual readings, expressed in magnitudes, from the mean of the set of four readings. The first three columns give the results of the three observers, and the fourth gives the mean. The second set of four columns gives in like manner the observed difference in brightness of the two images, a plus sign denoting that image A is the brighter.

Of course all these values should be zero were there no error. The results obtained by each observer, and their mean, are stated in separate columns as before. The last group of four columns shows in how many cases image A appeared by the measurements to be brighter than image B. If each of the four settings made it brighter, the number "4" is entered. If it was fainter in all cases a "0" is inserted. The last column gives the sum and not the mean of the three preceding it, and shows how many out of the twelve signs are plus. The last line of the Table gives the mean of

columns two to nine, and the sum of columns ten to thirteen. The total number of signs in columns ten to twelve is twenty, and in column thirteen it is sixty.

TABLE X.
EFFECT OF DISTANCE.

Dist.	Average Deviations.				Differences in Magnitude.				No. Obs. in which A > B.			
	P.	S.	U.	Mean.	P.	S.	U.	Mean.	P.	S.	U.	Sum.
60	.05	.11	.09	.08	+.19	+.01	+.11	+.10	4	2	4	10
20	.03	.04	.08	.05	+.15	+.21	.00	+.12	4	4	2	10
10	.03	.07	.06	.05	+.08	-.02	+.02	+.03	4	2	2	8
5	.03	.07	.06	.05	-.00	-.02	-.14	-.05	2	2	2	6
3	.12	.31	.03	.15	+.08	-.09	-.11	-.04	2	2	0	4
	.05	.12	.06	.08	+.10	+.02	-.02	+.03	16	12	10	38

An examination of the average deviations shows that for distances between 5" and 60" there is no sensible variation in the accuracy of the settings. There is danger, however, especially when the seeing is not good, that less accordant results will be attained if the images are brought too near.

The columns of systematic deviations show that when the interval between the images was large, image A appeared brighter than B. This is best shown in the last column of the table, according to which, when the distance was 60" or 20", A seemed brighter than B in ten of the twelve observations. The cause is probably the difference in the zero point in different parts of the field. It has already been shown that this differs about 3° for the two edges of the field or for a distance of 130".

The effect of a change in direction of one image from the other was next examined. The two images were placed about 5" apart, first side by side, then one above the other, and afterwards in the two intermediate oblique positions. In other words, they were observed in four positions, distant angularly 45°. To study at the same time the effect of a change in brightness, three stars of about the fifth, seventh, and ninth magnitudes, were successively observed. The stars selected for this purpose were 51 *Cephei*, λ *Ursæ Minoris*, and DM. + 89° 3, the choice being determined by their proximity to the pole. They represent the bright, the medium, and the faint components of the double stars in the list now under consideration. Eight sets were taken of λ *Ursæ Minoris*, moving the photometer 45° each time, so as to show the effect of interchanging the planes of polarization. These observations are given in Table I., Nos. 3435-3450, 3471-3478, 3510-3538.

Table XI. gives the average deviations for these various sets. The first column gives the position angle of B from A except for the readings marked with an asterisk,

where the angle is that of A from B. The table is divided into three parts, corresponding to the three observers. Each part contains five columns, the first giving the observations of 51 *Cephei*, the second and third those of λ *Ursæ Minoris*, the fourth those of DM. $+ 89^\circ 3'$, which is denoted by m , and the fifth their mean. Table XII. gives in like manner the mean value for each set. The position angle is reckoned from B in the observations marked with an asterisk, and in those cases the sign has been changed, to show what the reading would have been had the angle been reckoned from A. This assumes that the deviation is due to the judgment of the observer, and not to the plane of polarization. The last line in this Table and in the preceding gives the mean of the numbers in each column. The number of plus signs used in forming Table XII. is shown in Table XIII. The sums are taken instead of the means in the last columns of each part. They show the number of plus signs out of sixteen. The last line also shows the number of plus signs out of sixteen, except the sums of the columns headed "Sum," where the total number is sixty-four.

TABLE XI.

EFFECT OF POSITION ANGLE; MEAN DEVIATIONS.

P.						S.					U.				
Angle.	51	λ	λ	m .	Mean.	51	λ	λ	m .	Mean.	51	λ	λ	m .	Mean.
°															
90	.03	.08	.06*	.06	.06	.10	.09	.04*	.07	.07	.09	.11	.03*	.07	.05
135	.11	.04	.09*	.04	.07	.08*	.14	.03*	.18	.11	.06	.02	.03*	.04	.04
180	.05	.05	.07*	.08	.06	.18*	.14	.09*	.05	.11	.06*	.17	.09*	.16*	.12
225	.06	.07	.04*	.12	.07	.29*	.13	.05*	.15	.16	.05*	.11	.03*	.04*	.06
	.06	.06	.06	.08	.06	.16	.12	.05	.11	.11	.06	.10	.04	.08	.07

TABLE XII.

EFFECT OF POSITION ANGLE; MEAN RESULTS.

P.						S.					U.				
Angle.	51	λ	λ	m .	Mean.	51	λ	λ	m .	Mean.	51	λ	λ	m .	Mean.
°															
90	+.13	+.23	+.31*	+.20	+.22	+.20	+.16	+.16*	+.03	+.04	-.25	-.07	-.14	-.19	-.16
135	-.04	-.15	+.20*	+.38	+.10	+.38*	+.32	+.27*	+.20	+.29	-.14	+.01	-.06*	+.15	-.01
180	-.20	-.24	-.10*	+.19	-.09	+.18*	+.24	+.12*	+.23	+.19	+.16*	+.04	-.04*	+.19*	+.09
225	-.10	-.19	-.18*	-.02	-.12	+.31*	+.21	-.11*	-.11	+.07	+.27*	-.01	+.05*	+.04*	+.09
	-.05	-.09	+.06	+.19	+.03	+.27	+.23	+.11	+.09	+.15	+.01	-.01	-.05	+.05	+.00

* Position angle of A from B.

TABLE XIII.

EFFECT OF POSITION ANGLE; NUMBER OF OBSERVATIONS IN WHICH $A > B$.

P.						S.					U.				
Angle.	51	λ	λ	m .	Sum.	51	λ	λ	m .	Sum.	51	λ	λ	m .	Sum.
0															
90	4	4	4*	4	16	3†	4	4*	2	13	0	1	0*	0	1
135	2	0	4*	4	10	4*	4	4*	3	15	2	2†	0*	4	8
180	0	0	0*	4	4	3*	4	3*	4	14	4*	2	1*	4*	11
225	0	0	0*	2	2	3*	2†	2*	1	8	4*	2	3*†	2*†	11
	6	4	8	14	32	13	14	13	10	50	10	7	4	10	31

An examination of Tables XI.–XIII. fails to establish a difference in the accuracy of the observations dependent on the brightness of the stars, or on the direction of one image from the other. The mean of the whole shows that the average deviation of a single setting is eight one-hundredths of a magnitude.

A tendency to systematic errors dependent on the position angle shows itself in Table XII. This is most marked for the angle 90° . Both Mr. Searle and the writer made the left-hand image too bright in each set, while Mr. Upton made it too faint by a nearly equal amount. Table XIII. verifies this conclusion, showing that the number of plus signs was 16, 13 and 1 out of 16 observations in each case. There are other less marked examples, but too much confidence must not be placed on them, as accidental coincidences are not improbable. For example, it is very unlikely that any thing but chance gives the preponderance of plus signs to the observations of m . The means for the three observers from Table XII. are $+.19$, $+.09$, and $+.05$, while the number of plus signs is 14, 10, and 10, or 34 out of 46, two being zero. Fortunately, if there is such a systematic error at 90° or other angles, it will be completely eliminated in the double star measures by the reversion of the images. Its only effect will be to increase the mean deviation, and make the results appear less accordant than they really are.

It next becomes important to determine the effect of the plane of polarization. For this purpose we must change the sign of all the observations in Table XII. which are marked with a star, and take the mean. This gives for the three observers $-.00$, $+.09$, $-.05$, or the mean of all $-.01$, a wholly inappreciable quantity. Table XIII. also shows that when the signs are changed the three observers made 32, 36, and 25 positive observations out of 64 each, or 93 in all out of 192. As six of the observations were zero, it happens that the number of plus and minus signs were the same. We may therefore conclude that there is no appreciable difference in brightness of the two images.

* Position angle of A from B.

† One reading zero.

‡ Two readings zero.

It not unfrequently happened when observing the double stars, that one image looked larger than the other, as if it were a little out of focus. It was suggested that this might really be the case, and might be a source of systematic error. To detect it, five sets of measures of λ *Ursæ Minoris* were made by each of the three observers. The distance of the images was 5" and the angle 90°. In order to determine the focus, the position of the eye-piece in which the stars were most distinctly seen was determined by each observer five times in succession, and the mean of these five determinations was assumed as the setting best suited to the eye of that observer. The mean deviation, with the power used of 250, amounted only to .03 cms. in the whole focal length of 682.5 cms., or the focus is thus determined with a probable error of only .01 cms. Five sets were then taken of λ *Ursæ Minoris* altering this focus by $-.2, -.1, 0, +.1$ and $+.2$ cms. respectively. The results are given in Table XIV., in which the first column gives the change in the focus. The other columns have precisely the same values as in Table X.

TABLE XIV.
EFFECT OF FOCUS.

Focus.	Mean Deviations.				Differences in Magnitude.				No. Obs. in which A > B.			
	P.	S.	U.	Mean.	P.	S.	U.	Mean.	P.	S.	U.	Sum.
$-.2$	.06	.05	.13	.08	$+.06$	$+.16$	$-.06$	$+.05$	3	4	1	8
$-.1$	.12	.03	.02	.07	$+.20$	$+.25$	$-.01$	$+.15$	3	4	1	8
$.0$	.03	.15	.05	.08	$+.18$	$+.08$	$-.10$	$+.05$	4	3	0	7
$+.1$	.17	.17	.09	.14	$+.26$	$+.11$	$+.02$	$+.13$	3	2	2	7
$+.2$	.06	.02	.06	.05	$+.20$	$+.26$	$+.03$	$+.18$	4	4	2	10
	.09	.08	.07	.08	$+.18$	$+.17$	$-.02$	$+.11$	17	17	6	40

The values of the mean deviations do not show any variation within the limits of the Table. In other words, the accuracy is not impaired if the images are thrown slightly out of focus. The systematic errors also do not seem to change with the focus, although the readings of both Mr. Searle and myself show a tendency to make image A a little too bright. From the columns giving the number of plus signs, it appears that each of us gave a plus value in seventeen out of twenty settings. As these readings followed each other closely, the estimate of the relative brightness being once made, was repeated over and over in all five sets.

Observations were made on the evening of July 20, 1878, to see if a different focus was required for the two images. The telescope being set on λ *Ursæ Minoris*, it was focused five times on one of the images. The photometer was then turned 180° and the settings repeated. The distance between two points, one attached to the telescope,

the other moving with the eye-piece, was found by Mr. Upton to be 1.94 and 1.86 in the two cases. The average deviations of the single settings from these means were .07 and .03. Mr. Searle in like manner obtained the values 2.02 and 2.02, with average deviations of .03 and .06. In this case the photometer was not turned, but first the right-hand, and then the left-hand image was observed.

A better method was employed on August 30, 1878. The telescope was turned to ϵ *Bootis*, which has two components 3" distant, and one image being extinguished by the Nicol, the eye-piece was focused on the other. The Nicol was then turned 90° so that the first image was extinguished. Ten alternate readings were thus obtained, five of each image. My own readings gave 2.11 and 2.06 with average deviations of .05 and .02. Mr. Upton obtained 1.96 and 1.97 with deviations .03 and .02. The advantage of these readings over the preceding is that, by the alternation, any systematic error is in a great measure eliminated. The differences in the mean values of the focus are probably accidental. Their average value is only .035, which is less than the average deviation of a single reading, or .039. The latter confirms the statement on page 169, that the telescope may be focused with an average deviation of less than one-hundredth of an inch.

An excellent test of the freedom of the result of Table V. from systematic error is afforded by the multiple star θ *Orionis*. This object, situated near the brightest portion of the great Nebula of Orion, contains four conspicuous components known as the trapezium, and designated in the order of brightness A, B, C, and D. A is the southern star, B the preceding, C the following, and D the northern. The greatest distance between any two of these stars is 21", and the least 9". A comparison of each star with the other three was made in the following order, AB, AC, AD, BC, BD, and CD. These six sets were repeated eight times on four different nights; three times by Mr. Searle, once by Mr. Upton, and four times by myself. The mean differences of magnitude thus obtained, as shown in Table IV., are $AB = 1.46$, $AC = 1.47$, $AD = 2.62$, $BC = .17$, $BD = .92$, $CD = 1.22$. From these six values the most probable results for the relative brightness of the four components may be determined by the method of least squares, either in the form explained by Argelander in No. 491 of the *Astronomische Nachrichten*; or, since only four stars are to be considered, still more directly by adopting as the unknown quantities x , y , and z , the respective differences of magnitude between A and B, B and C, C and D, so as to allow the normal equations to be formed without changes of sign. Letting a , b , c , d , e , and f represent the observed differences AB, AC, AD, BC, BD, and CD, the simultaneous equations furnished by observation become, —

$$\begin{array}{rcl}
 x & = & a \\
 x + y & = & b \\
 x + y + z & = & c \\
 y & = & d \\
 y + z & = & e \\
 z & = & f,
 \end{array}$$

and the corresponding normal equations are, —

$$\begin{array}{rcl}
 3x + 2y + z & = & a + b + c \\
 2x + 4y + 2z & = & b + c + d + e \\
 x + 2y + 3z & = & c + e + f.
 \end{array}$$

Hence, —

$$\begin{aligned}
 x &= \frac{1}{4} (2a + b + c - d - e) \\
 y &= \frac{1}{4} (-a + b + 2d + e - f) \\
 z &= \frac{1}{4} (-b + c - d + e + 2f).
 \end{aligned}$$

Substituting the observed values in the above equations gives $x = 1.48$, $y = .01$, and $z = 1.08$. Comparing these quantities with the original equations, —

		Comp.	Obs.	C. - O.
A B = x	=	1.48	1.46	+.02
A C = $x + y$	=	1.49	1.47	+.02
A D = $x + y + z$	=	2.58	2.62	-.04
B C = y	=	.01	.17	-.16
B D = $y + z$	=	1.10	.92	+.18
C D = z	=	1.08	1.22	-.13.

The mean deviation is accordingly .09, which is no larger than may be expected, the mean deviation of one set being .13.

If the star is triple, the above formulæ are much simplified. Using the same letters as before, but omitting the equations involving z , we obtain the normal equations $2x + y = a + b$, and $x + 2y = b + d$, whence $x = \frac{1}{3} (2a + b - d)$, and $y = \frac{1}{3} (-a + b + 2d)$.

The proximity of a bright star greatly reduces the apparent brightness of a faint object, and thus renders it difficult to estimate its light correctly. If a proper allowance is not made, large systematic errors may occur in estimating the magnitudes of unequal double stars. An instance of this has been already shown on page 103 in the comparisons of Saturn and Mars. The amount of the error thus caused was measured by placing the two images of the pole star at various distances apart, and reducing the light of one until it appeared equal to the companion. A set of four readings was made by each observer, making the interval between the images successively 60", 40", 18", 10", and 5". An additional set was taken by Mr. Searle with the images 3" apart. The distance of the companion being 18", the images in the third set were arranged in a rhombus; in other cases they were placed in line. The results are shown in

Table XIII., in which the first column gives a current number, and the second the distance of the images. The remaining columns are arranged in three groups of five each, corresponding to the measurements of each observer. The first column of each group gives the number in Table I., the second the reading, the third the corresponding difference in magnitudes, and the fourth the error, assuming the mean value found in Table V. of 6.6 to be the true difference in brightness of the star and its companion. The fifth column gives the initial of the observer.

TABLE XIII.
PROXIMITY OF A BRIGHT STAR.

No.	Dist.	No. in Table I.	Read- ing.	Diff. in Magn.	Resid. in Magn.	Obs.	No. in Table I.	Read- ing.	Diff. in Magn.	Resid. in Magn.	Obs.	No. in Table I.	Read- ing.	Diff. in Magn.	Resid. in Magn.	Obs.
1	60	3642	.80	9.02	+ 2.40	P.	4103	.72	9.50	+ 2.90	S.	3648	1.10	8.58	+ 1.98	U.
2	40	3643	1.65	7.70	+ 1.10	P.	4104	2.22	7.05	+ .45	S.	3649	1.70	7.64	+ 1.04	U.
3	18	3644	2.60	6.71	+ .11	P.	4105	2.92	6.46	- .14	S.	3650	3.20	6.26	- .34	U.
4	10	3645	3.17	6.28	- .32	P.	4106	3.70	5.95	- .65	S.	3651	3.87	5.84	- .76	U.
5	5	3646	4.07	5.74	- .86	P.	4107	4.80	5.38	- 1.22	S.	3652	5.15	5.22	- 1.38	U.
6	3						4108	9.07	3.78	- 2.62	S.					

These measurements show that a variation of over three magnitudes might be made in estimating the brightness of a companion to a star of the second magnitude, if the distance varied from 5" to 60". In all the cases given above, the bright image of the pole star remained in the field. In No. 4109, placing it outside of the field, the reading became 1.80 instead of .72, or the error was much reduced. The corresponding difference in magnitude is 7.51, and the error, +.91.

When a bright star has two or more faint companions, the apparent brightness of each should be reduced by an amount increasing as the distance diminishes. This is well shown by the triple star θ *Virginis*. The two companions, distant 7" and 65", appear to the eye of nearly equal brightness. They are commonly estimated as of the 9 and 10 magnitude. The measurements show a difference of 2.53 magnitudes. π *Arietis* has two companions, distant 3" and 25", which were estimated by Struve as of 8.7 and 10.2 magnitude, or differing 1.5 magnitudes. Their measured difference is 2.88. Struve assigned to the brighter companions of σ *Orionis* magnitudes of 7.0 and 7.5, and distances of 41" and 13". The measurement makes the difference in light .23 magnitudes. Struve estimated the magnitude of the close companion of 39 *Draconis* as a tenth of a magnitude fainter than the distant companion, while the measurement makes it 0.3 magnitudes brighter. An opposite result is obtained with ι *Cassiopeiæ*, but the difference is only .13 magnitudes, and may be due to errors of observation. It is not surprising that the effect of the bright star is not shown in this case, as it is

only about three magnitudes brighter than its companions, and as the more remote of these is only $7''$ distant.

The companions of μ *Sagittarii* are nearly equally distant, and although they conform to the rule, the slight difference may be due to accident. Of the remaining stars which have been measured, λ *Orionis*, ζ *Orionis*, α *Geminorum*, and σ *Coronæ* are alone available as tests. All of these, except the last, show a reduction in light of the nearer star; but the apparent difference in magnitude of the two companions is so great that the deviation cannot with certainty be distinguished from a variation of the scale of the observer from that adopted in the present volume.

On the evening of Aug. 28, 1878, an excellent instance of the effect of a bright object on an adjacent faint star was noted. On looking at Saturn, two satellites were seen, one very near the southern limb of the planet, the other following it at some distance. To the eye, when Saturn was in the field, these satellites appeared very nearly equal, both to Mr. Upton and myself, before we had identified them. They were then measured with Photometer H in sets 3661 and 3662, placing the images at equal distances from Saturn. This proved to be a matter of no little difficulty, as the air was somewhat hazy, and the satellites, when reduced by the prisms, were scarcely visible. These measures showed that the nearer satellite really exceeded the other in brightness by 1.31 and 1.30 magnitudes. To verify so great a difference, the Nicol was set 45° from the zero point, or so that both images should be reduced by an equal amount, retaining them at the same distance from the planet. The difference in brightness was now unquestionable, the nearer satellite being easily seen, while the other was almost, if not quite, invisible. A comparison with the ephemeris showed that the satellite near Saturn was Titan and the other Rhea. Their true difference in brightness was therefore 1.4 magnitudes, according to the measurements to be described later.

It is evidently desirable to show that in the measurements now under consideration the above source of error is eliminated; in other words, that the eye will judge correctly of the equality of two images when placed at equal distances from a bright object, even if their real distances are unequal. The most conclusive evidence of this is found in the occultations and transits of Jupiter's satellites. When near Jupiter, these objects appear very faint, and with a low power they may disappear before occultation really takes place. This cannot be due to a change in reflecting power in a particular part of their orbits, as in the case of Iapetus, the outer satellite of Saturn, since it occurs at about the same distance from Jupiter when the latter is in opposition or in quadrature. If Jupiter possessed an atmosphere extending beyond its apparent disk, and if this atmosphere was not perfectly transparent, the intrinsic brightness of a satellite would be reduced. The effect would be double, since the satellite would

receive less light from the sun, and part of what it reflected would be lost by absorption. Immediately before or after a transit, on the other hand, the atmosphere of Jupiter could exert no influence on the satellite. The apparent loss of light may also be explained as a subjective phenomenon due to the bright light of Jupiter. The effect of this would be the same whether the satellite passed behind or in front of the planet. Measurements of the light shortly before occultations and transits would therefore show to which of the above causes this phenomenon was due. On Aug. 7, 1878, a series of measurements was made in which the light of satellite I, for several minutes before its occultation, was compared with satellite II by Photometer H. Care was taken to place the two images at the same distance from the planet. The respective columns of Table XIV. give the current number, number in Table I., Cambridge mean time in hours and minutes, distance in seconds of the centre of the satellite from the edge of Jupiter, the mean reading, the zero, the difference in magnitudes, the residual from the mean, and the observer.

TABLE XIV.

OCCULTATION OF JUPITER I.

No.	No. in Table I.	C. M. T.		Dist.	Reading.	Zero.	Diff. in Magn.	Resid. in Magn.	Obs.
		<i>h.</i>	<i>m.</i>	<i>''</i>					
1	3451	11	34	11	38.4	225.2	.40	— .01	P.
2	3452		39	9	41.2	227.0	.29	— .12	S.
3	3453		43	8	38.6	226.1	.49	+ .08	P.
4	3454		48	6	38.7	227.0	.48	+ .07	P.
5	3455		52	5	38.6	227.6	.49	+ .08	P.
6	3456		57	3	40.0	226.9	.38	— .03	P.
7	3457	12	2	1	42.0	228.0	.22	— .19	P.
8	3458		4	1	39.0	227.8	.46	+ .05	P.
9	3459		6	0	37.7	225.5	.56	+ .15	P.
10	3460		7	0	40.2	224.9	.37	— .04	P.
							.41	± .08	

In the eighth set the image of the satellite appeared to touch the edge of the disk, in the ninth it was half gone, and in the tenth a small portion only remained visible. In those sets, care was taken to compare the intrinsic brightness of the two images, and not their total light. From the residuals, it is obvious that no sensible variation took place in the light of the satellite, or that the apparent reduction is due to the proximity of Jupiter, and not to the absorption of an atmosphere. It was therefore unnecessary to repeat the observation before a transit of the satellite. It is also evident that the photometer gave good results when subjected to a somewhat severe test.

The apparent diminution in brightness of the edges of Jupiter's disk is commonly accepted as evidence of the existence of an atmosphere. This diminution is probably

real, and not due to contrast, since a satellite during transit is often seen as a bright object on a dark background when near the limb of Jupiter, while it cannot be distinguished from the planet when near its centre. An attempt was made to measure the amount of variation of the light by the following method. A time was selected when the shadow of one of the satellites was cast upon the planet, the satellite itself having passed off the disk. An image of the satellite was then superposed upon its shadow by Photometer H, which was done by moving the prism and rotating it. By turning the Nicol, the satellite could be made to appear as a bright spot on a dark background, or as a dark spot on a bright background, according as the image of the satellite or planet was the brighter. When of equal brightness, the satellite entirely disappeared, so that measurements could be made as with a Bunsen photometer. By repeating the observation as the shadow passed off the disk, the light of different portions of the latter could be determined. The distance from the edge was found from the time, and the corresponding light from the reading of the circle.

Table XV. gives the results of thirteen sets of measurements made in this way. The successive columns give the current number, the number in Table I., the date, the hour and minute in Cambridge mean time, the distance of the shadow from the edge of the disk, the number of the satellite, the reading, the zero, the excess in the brightness of the satellite over that of adjacent portions of the disk, the initial of the observer, and explanatory remarks. Surfaces are here compared in stellar magnitudes. The analogy is obvious if we regard them as subdivided into minute portions of equal area.

TABLE XV.
BRIGHTNESS OF JUPITER'S DISK.

No.	No. in Table I.	Date.	C. M. T.		Dist.	Sat.	Reading.	Zero.	Diff. in Magn.	Obs.	Remarks.
1	3221	July 7	h. 15	m. 7	" 6	II	49.0	140.3	-.30	P.	Sat. II on shadow of I. Shadow on upper edge of lower belt. Definition poor.
2	3778	Sept. 9	7	52	14	I	44.1	147.6	.07	P.	
3	3779	" "	7	56	12	I	42.0	145.7	.23	P.	
4	3780	" "	8	1	10	I	45.0	146.0	.00	P.	
5	3781	" "	8	10	8	I	46.6	144.8	-.12	P.	
6	3782	" "	8	14	6	I	43.6	142.1	.11	P.	
7	3783	" "	8	20	5	I	48.0	146.4	-.23	P.	Shadow close to edge. Shadow almost gone.
8	3784	" "	8	25	3	I	35.0	145.6	.77	P.	
9	3785	" "	8	28	2	I	41.6	143.8	.26	P.	
10	4094	Sept. 29	6	28	11	II	42.0	53.8	.23	P.	[with difficulty. Shadow near edge, seen
11	4095	" "	6	41	9	II	41.8	143.6	.24	P.	
12	4096	" "	6	49	7	II	42.6	52.2	.18	S.	
13	4097	" "	7	3	3	II	42.5	152.6	.18	P.	

The results are less conclusive than might be desired, owing to the difficulty of the observation. When the shadow is near the limb, good measurements cannot be made,

unless the air is exceptionally steady. So far as they go, they throw doubt on any considerable diminution of light at a distance from the edge greater than two or three seconds.

Admitting that the edges of the disk are really darker than the centre, it does not necessarily follow that this must be due to an atmosphere extending to a height sufficient to be visible beyond the apparent surface of the planet. The effect would be greater for a shallow opaque atmosphere, like that of our earth, than for one many thousand miles in height and correspondingly transparent; since in the first case the relative thickness at the edges compared with that at the centre is much greater. It should also be noticed that, assuming that the entire light of Jupiter is reflected sunlight, the effect of a semi-transparent atmosphere would make the edges brighter than the centre, if its color was lighter than that of the planet. We may conclude, therefore, that there is no evidence of an atmosphere extending beyond the visible disk, and that the reduction in light of satellites and faint stars is subjective, and not due to absorption.

The possibility of detecting a polarization of the companions of a bright star has already been suggested on page 106. Observations were made from time to time to determine the direction of the plane in each image. In general, during 1878, when the zero-point in a set of four readings lies between one and two hundred, the image of the fainter star, *B*, Fig. 7, p. 105, is polarized in a plane passing through *b*. If, however, the sum of the zero-point and the reading exceeds 180° , the planes are reversed, that of the brighter star, *a*, passing through *A*. Occasionally this sum will approach very nearly to 180° , and we cannot then be sure of the direction of the plane of polarization without a reference to the original readings, since an accidental error in the first setting may carry it to one side or the other of the 0° .

When the zero lies between two and three hundred, the plane of the image of the brighter star, *a*, passes through *A*, unless the sum of the zero-point and reading exceeds 270° .

Let us now suppose that the images were in line, that the companion shone by reflected light, and was polarized in a plane passing through its primary. In the first of the cases named above, or when the plane of the image *B* passed through *b*, the observed difference in magnitude should appear too small, and the residual in Table IV. would be negative. When the plane of *a* passed through *A*, the difference in magnitude would be too great and the residual positive. A comparison of the residuals corresponding to the two positions of the zero-point, would therefore show the direction and amount of the polarization.

When the images are nearly in line, or when the angles *A* and *b* of the rhombus are very small, the same rule may be applied. If, however, these angles equal 45° ,

this effect will be neutralized, an equal portion of the light passing into each image. When the angle exceeds 45° , an opposite effect is attained, the sign of the residuals being reversed. The difference in the two images attains its maximum when the angles at A and b equal 90° and then diminishes to 135° .

The examination hitherto made of the residuals does not establish the existence of a perceptible polarization of the light of any star. The discrepancies in the early measurements of γ Ceti were at first ascribed to this cause. They were accordingly repeated until it was evident that the variations were accidental. The large number of measurements of this star are thus explained. In several of the sets, the angles at A and b were made 90° , or the images were arranged in a square, to reverse the effect of the polarization; the images diagonally opposite were observed alternately, turning the circle in one direction, so that each pair in turn should appear of equal brightness. On January 25, the angles at A and b were made 45° , so that the effect of any polarization should be eliminated. On January 19, the images were arranged in a square, but a was compared with A , b with B . The readings do not differ sensibly from 45° , the value they should have if the light was unpolarized.

There is undoubtedly a difference in the two images, as this was repeatedly noticed when very bright stars were observed. In several cases the image of a , when polarized in a plane perpendicular to A (or the extraordinary image), would not disappear when the Nicol was turned. A possible explanation is, that, in the case of double refraction, the polarization is slightly elliptical. This view is corroborated by the fact that if the sun is looked at through crossed Nicols, its disk appears traversed by a dark band, at no place perfectly black. In this case, a small portion of the light is transmitted, although, as the angle is greater than that of total reflection, all of the ordinary ray is cut off. Another explanation of this phenomenon is, that it is due to dust or grease upon the inclined surface of the prism.

It is not uncommonly supposed that the companion of Sirius shines merely by reflected light. If the irregular proper motion of this star is accounted for by its revolution around its companion, it is evident that the intrinsic brightness of the latter must be far less than that of Sirius. The alternative of assuming that the difference is due to the greater density of the companion is too improbable to deserve consideration. The measurements given in Table IV. show that if the objects had equal mass and equal intrinsic brightness, the density of the companion must be a million times that of Sirius.

It is not easy to detect a slight polarization of the light of the companion. Although not a difficult object in the Cambridge telescope, it is not easily seen when the photometer is attached. Most of the measurements of its light have accordingly been made at dusk when the glare of the brighter star is reduced. Six settings were com-

monly taken, three on each side of one of the points of disappearance of the principal star, the bright image being thrown out of the field. If observed in the usual way, the eye would have been dazzled by the intense light. In the second set, ten readings were made.

The plan was tried of comparing the two images of the companion directly, as had been done in the case of γ *Ceti*. Since, however, the double-image prism reduced the light one-half, and the Nicol reduced each image again one-half when they were rendered equal, they then became too faint to be measured.

The measurement of the light given in Table IV. permits the application of a second test. If the light is wholly due to reflection from Sirius, we can compute the minimum angular diameter of the disk, and then see whether it would be possible to detect it by its appearance in a telescope with a high magnifying power.

Let A represent the primary and B the secondary.

D = the apparent distance of B from A in seconds.

d = the apparent diameter of B in seconds.

M = the albedo of B , or ratio of light emitted to that received.

v = the angle between the observer and A as seen from B .

a = the angular diameter of B as seen from A .

L = the apparent brightness of A .

l = the apparent brightness of B .

The true distance of B from A will equal $\frac{D}{\sin v}$. Accordingly, $\sin \frac{1}{2} a = \frac{d \sin v}{2 D}$.

Of the entire light radiated by A , the portion $\frac{1}{2} \text{versin } \frac{1}{2} a$ will be intercepted by B . The amount reflected at any angle v will be some function of this angle multiplied by the albedo or $l = \frac{1}{2} LM \text{versin } \frac{1}{2} a f(v)$. As v varies, the area of the illuminated portion of B which will be visible will alter, as in the case of our own Moon. The simplest supposition that we can make is, that the light will be proportional to this area, and that $f(v)$ equals unity when $v = 0$, or the phase corresponds to that of full moon. This hypothesis, which was adopted by Euler and Herschel, gives $f(v) = \frac{1 + \cos v}{2} = \cos^2 \frac{1}{2} v$. It has been shown, however, by Professor G. P. Bond, that, in the case of our Moon, $f(v) = \cos^6 \frac{1}{2} v$ agrees more nearly with observation.

If we assume $f(v) = (\cos^2 \frac{1}{2} v)^n$ we have $l = \frac{1}{2} LM \text{versin } \frac{1}{2} a (\cos^2 \frac{1}{2} v)^n$. But $\text{versin } \frac{1}{2} a = 2 \sin^2 \frac{1}{4} a$, and since a cannot be very large (or the disk of the companion would be easily visible from the earth), we may assume that $\sin^2 \frac{1}{4} a = \frac{1}{4} \sin^2 \frac{1}{2} a = \frac{d^2 \sin^2 v}{16 D^2}$. Hence $l = \frac{L M d^2 \sin^2 v}{16 D^2} (\cos^2 \frac{1}{2} v)^n = \frac{L M d^2}{4 D^2} \sin^2 \frac{1}{2} v (\cos^2 \frac{1}{2} v)^{n+1}$. This will attain its maximum value when $\sin \frac{1}{2} v \cos^{n+1} \frac{1}{2} v$ is a maximum. Differentiating, we obtain $\tan \frac{1}{2} v = \sqrt{\frac{1}{n+1}}$. If $n = 1$, this corresponds to $v = 70^\circ 32'$, and

$l = .037 \frac{L M d^2}{D^2}$ or $d = 5.2 D \sqrt{\frac{l}{L M}}$. M cannot exceed unity, and substituting this value with $D = 10''$ and $\frac{l}{L} = .0001$, we obtain $d = 0''.52$. On this supposition, B should appear as a gibbous moon with a diameter at right angles to AB of $0''.52$ and of $0''.35$ parallel to AB. The dimensions of B cannot be less, and if, when the photometric measurements of the companion were made, the angle v was not $70^\circ 32'$, or if the albedo is much less than unity, the apparent diameter should be greater.

If $f(v) = (\cos^2 \frac{1}{2} v)^3$, as in the case of our Moon, the maximum value of l will be attained when $\tan \frac{1}{2} v = \sqrt{\frac{1}{4}} = .500$, or $v = 53^\circ 8'$. This value gives $l = \frac{.020 L M d^2}{D^2}$.

Substituting $\frac{l}{L} = .0001$, $M = 1$, and $D = 10''$, gives $d = 0''.70$. In this case, therefore, or if the variation in light follows the law established for our Moon, the disk of the companion could hardly fail to be visible. In either case, the real diameter of the companion would exceed that of the orbit of the Earth. Since it is difficult to suppose that a half moon could give more than half the light of a full moon, it may be assumed that if the companion presents a maximum diameter of less than $0''.5$ it must shine in part by its own light. Of course in any case a part of its light will be reflected from Sirius.

It not unfrequently happens that the two components of a double star differ in color. Two methods were tried for measuring this difference. The first consisted simply in the repetition of the measurement, after interposing plates of red and of blue glass. Observations of this kind were made with γ *Andromedæ* in series 21, 22, and 23 of Tables IV. and V., and with β *Cygni* in series 202, 206, and 207. As the smaller component in each case is of a bluish color, while the brighter star is reddish or yellow, the red glass reduced the light of the faint star more than that of the bright component, and thus increased the difference in their brightness. The blue glass, on the other hand, cut off more of the brighter star, and accordingly diminished the difference in brightness. The observation referred to above shows that in the case of γ *Andromedæ* the difference in light of 2.85 becomes 3.26 with the red glass and 2.60 with the blue glass. With β *Cygni*, 2.14 becomes 2.54 with red, and 1.94 with the blue glass interposed.

A much more satisfactory measurement of the colors of these objects was obtained with Photometer O (see page 5, Fig. 3). The plate of spar, E , was first turned until the two images of the slit were brought into line. The principal plane of the spar was thus rendered parallel to the slit. A bright star was then brought into the portion of the field not covered by the diaphragm F , so that the entire spectrum might be seen. The instrument was focused so that the spectra were reduced to narrow lines of light, and the prism H then turned so that its edges should be parallel

to the slit. When this adjustment was exact, the space between the two spectra of the star was a rectangle instead of a rhomboid, the corresponding colors being just opposite each other. Accordingly when seen through the slit the two images would appear of the same color. These adjustments were made once for all. The double star was next brought into the field and the maximum brightness given to two of the four spectra by turning the Nicol so as to make the other two disappear. The photometer was rotated until the spectra were superposed. The edges of the prism were now perpendicular to the line connecting the two components of the double star. The photometer was turned 90° by the position circle, and this brought the edges of the prism, the slit, and the principal plane of the spar all parallel to the line connecting the stars. Four parallel spectra were now seen whose relative brightness could be altered at will by turning the Nicol. The telescope was moved so that the red ends of the spectra were visible through the slit, presenting the appearance of four red stars in line. The Nicol was then turned until the two central images appeared equal, and the four positions in which this equality was maintained were measured. The telescope was afterwards moved so that the yellow, green, blue, and indigo parts of the spectra should be visible, and the observations repeated. Measurements of β *Cygni* were made so near the limit of the spectrum, that the color was called violet. The parts of the spectra selected were those where the color was such that the wave-length was estimated to be about 65, 60, 55, 50, 45, and 40 millionths of a centimetre. Accuracy is not needed in this determination, since its effect upon the result is much less than that of the photometric errors.

Owing to the unavoidable chromatic aberration of the object-glass of the large telescope, all the spectra were much spread out at the blue end. This difficulty was remedied by changing the focus. Since the four colored images were in line, the source of error pointed out on page 171 was at first apprehended. This might be remedied by placing the bright image beyond the end of the slit; but there was danger that a portion of the image next it might be cut off. Probably the error in any case would be small, owing to the faintness of the images, and the effect on all the observations of the same star would be nearly the same.

The results of these measurements have already been given in Table IV. and V., Nos. 24 to 28, and 208 to 213. They show conclusively the difference in the spectrum of the two components of each star, and are believed to be the first quantitative measurement of the distribution of the light in the spectrum of a star.

A series of measurements was made to show what accuracy was to be expected in determining the light of a star by its limit of visibility. The four stars, α *Ursæ Minoris*, 51 *Cephei*, λ *Ursæ Minoris*, and DM. 89° 3, already selected for testing the photometer, were measured by their limit of visibility. The two images were sepa-

rated to their greatest distance, placed side by side, and one image thrown out of the field. The circle was then turned until the other image was barely visible. This was repeated in the four positions of the circle with each image. The results for each star are shown in Table XVI. The first six columns have the same meaning as in Table IV., except that the fifth column is found by taking five times the logarithm of the cosecant of the angle, and denotes the reduction of the image below its full brightness, instead of the difference of the two images. The seventh column is found by subtracting each number in column five from the corresponding value of DM. $89^{\circ} 3$, obtained on the same evening by the same observer with the same image. The eighth column gives the residual of these magnitudes from their mean, and the last column gives the initial of the observer.

TABLE XVI.

LIMIT OF VISIBILITY.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid.	Corr. Magn.	Corr. Resid.	Obs.
α URSAE MINORIS.								
1	3483	Aug. 11	.65	9.73	-3.25	7.01	-1.61	P.
2	3484	" "	.22	12.03	-.95	9.33	+.71	P.
3	3485	" "	.00	∞				S.
4	3486	" "	.05	15.30	+2.32	12.21	+3.59	S.
5	3557	Aug. 20	.15	12.91	-.07	7.62	-1.00	U.
6	3558	" "	.20	12.29	-.69	7.08	-1.54	U.
7	3563	Aug. 22	.05	15.30	+2.32	8.87	+.25	U.
8	3564	" "	.12	13.31	+.33	8.20	-.42	U.
				12.98	± 1.42	8.62	± 1.30	
51 CEPHEI.								
1	3487	Aug. 11	2.82	6.54	-1.80	3.84	-.70	P.
2	3488	" "	3.02	6.39	-1.91	3.67	-.87	P.
3	3489	" "	2.37	6.91	-1.39	3.82	-.72	S.
4	3490	" "	2.40	6.89	-1.41	3.75	-.79	S.
5	3559	Aug. 20	.30	11.41	+3.11	6.12	+1.58	U.
6	3560	" "	.30	11.41	+3.11	6.20	+1.66	U.
7	3567	Aug. 22	.45	10.52	+2.22	6.09	+1.55	U.
8	3568	" "	.65	9.73	+1.43	4.62	+.08	U.
9	3657	Aug. 29	2.65	6.68	-1.62	3.59	-.95	P.
10	3658	" "	2.83	6.54	-1.76	3.72	-.82	P.
				8.25	± 1.98	4.49	$\pm .97$	

No.	No. in Table I.	Date.	Reading.	Diff in Magn.	Resid.	Corr. Magn.	Corr. Resid.	Obs.
λ URSÆ MINORIS.								
1	3491	Aug. 11	5.20	5.21	— .65	2.49	+ .64	P.
2	3492	" "	5.55	5.07	— .79	2.37	+ .52	P.
3	3493	" "	4.25	5.65	— .21	2.51	+ .66	S.
4	3494	" "	4.80	5.39	— .47	2.30	+ .45	S.
5	3551	Aug. 20	3.87	5.85	— .01	.64	— 1.21	U.
6	3552	" "	2.73	6.61	+ .75	1.32	— .53	U.
7	3553	" "	2.30	6.98	+ 1.12	1.77	— .08	U.
8	3554	" "	2.02	7.26	+ 1.40	1.97	+ .12	U.
9	3561	Aug. 22	3.67	5.97	+ .11	1.54	— .31	U.
10	3562	" "	3.70	5.95	+ .09	.84	— 1.01	U.
11	3655	Aug. 29	5.65	5.03	— .83	1.94	+ .09	P.
12	3656	" "	5.07	5.27	— .59	2.45	+ .60	P.
				5.86	± .59	1.85	± .52	
DM. 89° 3.								
1	3479	Aug. 11	16.77	2.70	— 1.06			P.
2	3480	" "	16.60	2.72	— 1.04			P.
3	3481	" "	13.92	3.09	— .67			S.
4	3482	" "	13.62	3.14	— .62			S.
5	3555	Aug. 20	5.20	5.21	+ 1.45			U.
6	3556	" "	5.03	5.29	+ 1.53			U.
7	3565	Aug. 22	7.48	4.43	+ .67			U.
8	3566	" "	5.45	5.11	+ 1.35			U.
9	3653	Aug. 29	13.95	3.09	— .67			P.
10	3654	" "	15.85	2.82	— .94			P.
				3.76	± 1.00			

The images of *a Ursæ Minoris* could not be made to disappear. On August 29, their minimum brightness exceeded that which had been assumed as the limit of visibility; accordingly no readings of this star were taken on that day. The reading .00 on August 11 is explained in the same way.

The residuals in column six show that a variation of several magnitudes is to be expected in the observations by different persons on different days. Even when the results are rendered differential, as in column eight, by comparing all with the measurements of a single star, the variations are so large that the results have little value. Although, doubtless, much better accordance might be attained by practice, it is not probable that this method would ever equal the accuracy attained in the direct comparison of two stars.

A comparison will now be made of the differences in magnitude given in the "*Mensuræ Micrometricæ*" with the measurements contained in this volume. The principal object of this comparison is to afford a determination of the scale of magnitudes

adopted by Struve, so that the fainter component of any double star observed by him may be reduced to the scale of magnitudes adopted in this work. A second object will be the determination of the accordance of the estimates of Struve. It will be assumed that the measurements are sensibly free from systematic error, and that the accidental errors have the values deduced from the preceding discussion. To avoid repetition, the deviations of the observations of Struve will be described as errors, although as the scale of magnitudes is necessarily somewhat arbitrary, it does not follow that they are in all cases incorrect.

In Table XVII. the values in the column of Table V. headed $\Sigma - O$ are arranged in groups, like the average deviations and probable errors in Table VI. The table is divided into three parts corresponding to the grouping according to distances of the components, their differences in magnitudes, and the magnitude of the fainter component as estimated by Struve. The first column gives the limit of each group, the second the number of stars for which $\Sigma - O$, or the residual, is positive. The number of negative observations is given in the next column. This is followed by the total number of stars in the group, the sum of the positive residuals, of the negative residuals, their arithmetical sum, and their arithmetical difference. The last two columns give these sums and differences divided by the number of stars in each group. As one of the residuals is zero, the total number exceeds by one the number of positive and negative residuals. The composition of the groups differs slightly from that of Table VI. The principle followed is, that Table VI. is intended as a test of the observations of the present volume, while Table XVII. is a comparison of the estimates of Struve. For the binary stars, the distances used for Table XVII. are, therefore, those observed by Struve, and not the intervals at the present time. In like manner, when a star is repeated, the mean of the measurements is used, since otherwise double weight would be given to a single estimate by Struve. The variable stars β *Lyrae* and δ *Cephei* are also omitted.

TABLE XVII.

COMPARISON WITH SCALE OF STRUVE.

Limits.	No. +	No. -	Total No.	$\Sigma +$	$\Sigma -$	$\Sigma \pm$	$\Delta \pm$	$\frac{\Sigma \pm}{n}$	$\frac{\Delta \pm}{n}$
DISTANCE.									
" "									
0.0 to 2.9	16	1	17	7.60	.23	7.83	+ 7.37	.461	+ .434
3.0 " 4.9	17	3	20	8.54	.16	8.70	+ 8.38	.435	+ .419
5.0 " 9.9	21	8	29	11.42	1.63	13.05	+ 9.79	.450	+ .338
10.0 " 19.9	18	8	26	11.48	2.31	13.79	+ 9.17	.530	+ .353
20.0 " 39.9	18	19	38	7.91	6.83	14.74	+ 1.08	.388	+ .028
40.0 " 59.9	5	5	10	2.50	1.21	3.71	+ 1.29	.371	+ .129
60.0 " ∞	10	8	18	4.58	5.57	10.15	- .99	.564	- .055
	105	52	158	54.03	17.94	71.97	+ 36.09	.456	+ .228
DIFFERENCE OF MAGNITUDE.									
0.00 to .99	23	6	29	5.47	1.44	6.91	+ 4.03	.238	+ .139
1.00 " 1.99	12	8	20	4.19	1.20	5.39	+ 2.99	.270	+ .150
2.00 " 2.99	22	10	32	14.52	3.33	17.85	+ 11.19	.558	+ .350
3.00 " 3.99	9	11	21	5.06	2.37	7.43	+ 2.69	.354	+ .128
4.00 " 4.99	14	8	22	7.85	4.14	11.99	+ 3.71	.545	+ .169
5.00 " 5.99	13	6	19	8.62	4.61	13.23	+ 4.01	.696	+ .211
6.00 " 6.99	9	1	10	6.37	.21	6.58	+ 6.16	.658	+ .616
7.00 " 8.99	1	1	2	1.24	.17	1.41	+ 1.07	.705	+ .535
9.00 " ∞	2	1	3	.71	.47	1.18	+ .24	.393	+ .080
	105	52	158	54.03	17.94	71.97	+ 36.09	.456	+ .228
MAGNITUDE OF COMPANION.									
0.0 to 4.9	8	2	10	1.71	.88	2.59	+ .83	.259	+ .083
5.0 " 5.9	12	9	21	3.98	2.27	6.25	+ 1.71	.298	+ .081
6.0 " 6.9	16	7	23	7.20	1.56	8.76	+ 5.64	.381	+ .245
7.0 " 7.9	18	11	29	7.73	3.75	11.48	+ 3.98	.396	+ .137
8.0 " 8.9	13	12	26	10.03	3.52	13.55	+ 6.51	.521	+ .250
9.0 " 9.9	20	8	28	8.67	4.33	13.00	+ 4.34	.464	+ .155
10.0 " 10.9	12	2	14	10.21	1.46	11.67	+ 8.75	.834	+ .625
11.0 " 12.0	6	1	7	4.50	.17	4.67	+ 4.33	.667	+ .619
	105	52	158	54.03	17.94	71.97	+ 36.09	.456	+ .228

An inspection of the last column shows that when the stars were near together almost all the residuals were positive, or the small star appears by the estimate to be too faint. The third portion of the table shows that where a companion is faint, its brightness was underestimated, while bright companions were observed nearly as they

should be. In other words, the scale of Struve differs from the standard, the difference between consecutive magnitudes being too small. The scale of Herschel and of most other observers will therefore differ still more from this standard.

There seems to be no marked systematic error caused by differences of magnitude, except that due to the difference of the scales, or to the faintness of the small star when the difference in magnitude is large. This grouping is not therefore used in the further discussion of the systematic errors.

It will be noticed that about two-thirds of the residuals are positive, and that the average difference in the magnitude of the two components obtained by estimate exceeds the measurement by .229, or nearly a quarter of a magnitude.

To eliminate the systematic errors, points were constructed whose ordinates are given in the last column of the first portion of Table XVII., and whose abscissas equal the mean of the numbers in the first column. A similar construction was made for the last part of the Table. Smooth curves were then drawn through these points by the help of the method of bisections, described in volume X., page lx, of these Annals. If now corrections were applied to each double star by means of the ordinates of these two curves, the constant difference of .229 would be applied twice, or the resulting value of $\Sigma - O$ would be too small by .229. Moreover, as the estimates are only given to tenths of a magnitude, it will be much quicker and sufficiently exact to neglect the hundredths in applying the corrections. The following are the limits between which the same tenth of a magnitude may be applied as a correction. The constant difference of .229 is divided between the two curves, so that if each star is corrected, first for magnitude and then for distance, the positive and negative residuals will be nearly equal, or the constant difference will disappear. For magnitudes between 1.0 and 5.8 apply a correction of +0.1; between 5.9 and 8.9, 0.0; between 9.0 and 9.7, -0.1; 9.8 and 10.1, -0.2; 10.2 and 10.5, -0.3; 10.6 and 12.0, -0.4. The correction for distances between 0".0 and 4".9 is -0.4; between 5".0 and 13".9, -0.3; 14".0 and 22".9, -0.2; 23".0 and 36".9, -0.1; 37".0 and 60".9, 0.0; over 61".0, +0.1. Table XVIII. is formed by applying these corrections to the magnitudes estimated by Struve, and arranging the results as in Table XVII. The columns have the same meaning in both tables.

TABLE XVIII.

COMPARISON WITH SCALE OF STRUVE, AFTER FIRST CORRECTIONS.

Limits.	No. +	No. -	No. ±	$\Sigma +$	$\Sigma -$	$\Sigma \pm$	$\Delta \pm$	$\frac{\Sigma \pm}{n}$	$\frac{\Delta \pm}{n}$
DISTANCE.									
" "									
0.0 to 2.9	8	9	17	3.15	1.98	5.13	+1.17	.302	+.069
3.0 " 4.9	9	10	20	2.84	2.16	5.00	+ .68	.250	+.034
5.0 " 9.9	13	16	29	5.46	5.67	11.13	- .21	.384	-.007
10.0 " 19.9	12	14	26	5.63	5.16	10.79	+ .47	.415	+.018
20.0 " 39.9	12	25	38	3.89	10.51	14.40	-6.62	.379	-.174
40.0 " 59.9	5	5	10	1.80	1.51	3.31	+ .29	.331	+.029
60.0 " ∞	9	8	18	4.09	5.28	9.37	-1.19	.521	-.066
	68	87	158	26.86	32.27	59.13	-5.41	.374	-.034
MAGNITUDE OF COMPANION.									
0.0 to 4.9	3	7	10	.60	1.77	2.37	-1.17	.237	-.117
5.0 " 5.9	7	14	21	3.04	4.83	7.87	-1.79	.375	-.085
6.0 " 6.9	8	15	23	3.20	3.56	6.76	- .36	.294	-.016
7.0 " 7.9	12	16	29	3.36	5.78	9.14	-2.42	.315	-.083
8.0 " 8.9	12	13	26	6.54	5.23	11.77	+1.31	.453	+.050
9.0 " 9.9	13	14	28	3.59	7.45	11.04	-3.86	.394	-.138
10.0 " 10.9	9	5	14	4.22	2.57	6.79	+1.65	.485	+.118
11.0 " 12.0	4	3	7	2.31	1.08	3.39	+1.23	.484	+.176
	68	87	158	26.86	32.27	59.13	-5.41	.374	-.034

The last column of this table shows that the systematic errors are in a great measure eliminated, since the changes of sign are as frequent as is to be expected when the residuals are wholly accidental. Although this system of correction gives satisfactory results in the present case, where the principal stars are bright, yet it cannot be applied in all cases. This will be obvious if we consider the case of a wide double star, in which the two components are faint, and estimated by Struve to be of equal brightness. Evidently there would then be little chance for systematic error; but the application of the corrections given above would make the magnitudes differ by a considerable amount.

This difficulty is avoided in the following system, based, in part at least, on theoretical considerations. It is not probable that the scale assumed by Struve should agree exactly with that afterwards proposed on theoretical grounds. A correction dependent on the magnitudes of the components is therefore to be expected. The values already obtained from the third part of Table XVII. may be used; but if the

brighter component is fainter than the 9.0 magnitude, the correction must be applied to each component instead of to their difference.

Another probable source of systematic error pointed out in this volume is that due to the proximity of a bright star. This error will evidently increase with the difference in magnitude of the two components, and will diminish as their distance increases. The simplest supposition that we can make regarding the law of its variation is, that it varies in proportion to the difference in magnitude and inversely as the distance. The ratio of these quantities to the nearest tenth has been taken for each star, the unit of distance being a second of arc. Table XIX. is formed by grouping together all stars in which this ratio has the value given in the first column. The other columns are the same as in Table XVII.

TABLE XIX.

SCALE OF STRUVE. DISTANCE AND MAGNITUDE OF COMPANION.

Limits.	No. +	No. -	No. $\pm$	$\Sigma +$	$\Sigma -$	$\Sigma \pm$	$\Delta \pm$	$\frac{\Sigma \pm}{n}$	$\frac{\Delta \pm}{n}$
.00 to .04	15	15	30	4.94	7.20	12.14	- 2.26	.404	-.075
.05 " .14	25	16	42	9.26	4.34	13.60	+ 4.92	.324	+.117
.15 " .24	11	13	24	4.22	4.73	8.95	- .51	.373	-.021
.25 " .34	9	2	11	5.67	.29	5.96	+ 5.38	.542	+.489
.35 " .44	5	1	6	2.19	.25	2.44	+ 1.94	.407	+.323
.45 " .54	6	4	10	3.45	.90	4.35	+ 2.55	.435	+.255
.55 " .64	10	1	11	6.86	.23	7.09	+ 6.63	.645	+.603
.65 " .84	7	0	7	5.87	—	5.87	+ 5.87	.839	+.839
.85 " 1.04	7	0	7	4.57	—	4.57	+ 4.57	.653	+.653
1.05 " ∞	10	0	10	7.00	—	7.00	+ 7.00	.700	+.700
	105	52	158	54.03	17.94	71.97	+ 36.09	.456	+.228

The increasing magnitude of the numbers in the last column shows the presence of the systematic error due to the bright star. Constructing a curve as before, it appears that the results may be represented by a straight line, whose abscissas exceed the ordinates by one-tenth of a magnitude, provided the abscissa does not exceed 0.8. For values greater than 0.8 a constant correction of 0.7 may be applied. In Table XX., this correction and that due to the magnitude of the companion have been applied to the groups contained in the third part of Table XVII. and in Table XIX. The columns have the same meaning as in Tables XVII. and XIX.

TABLE XX.

SCALE OF STRUVE, AFTER APPLYING SECOND CORRECTION.

Limits.	No. +	No. -	No. $\pm$	$\Sigma +$	$\Sigma -$	$\Sigma \pm$	$\Delta \pm$	$\frac{\Sigma \pm}{n}$	$\frac{\Delta \pm}{n}$
MAGNITUDE OF COMPANION.									
" "									
0.0 to 4.9	7	3	10	2.50	.77	3.27	+1.73	.327	+.173
5.0 " 5.9	14	7	21	4.22	2.11	6.33	+2.11	.301	+.100
6.0 " 6.9	14	8	23	3.87	1.73	5.60	+2.14	.243	+.093
7.0 " 7.9	12	16	29	3.66	5.58	9.24	-1.92	.319	-.066
8.0 " 8.9	10	15	26	6.02	5.11	11.13	+.91	.428	+.035
9.0 " 9.9	9	19	28	2.26	8.62	10.88	-6.36	.389	-.227
10.0 " 10.9	8	6	14	2.96	3.11	6.07	-.15	.434	-.011
11.0 " 12.0	4	3	7	2.01	1.38	3.39	+.63	.484	+.090
	78	77	158	27.50	28.41	55.91	-.91	.354	-.006
DIFFERENCE OF MAGNITUDE DIVIDED BY DISTANCE.									
.00 to .04	19	10	30	7.30	5.76	13.06	+1.54	.435	+.051
.05 " .14	23	18	42	8.06	4.64	12.70	+3.42	.302	+.081
.15 " .24	7	17	24	2.49	7.40	9.89	-4.91	.412	-.205
.25 " .34	6	4	11	2.82	.94	3.76	+1.88	.342	+.171
.35 " .44	2	4	6	.71	1.07	1.78	-.36	.297	-.060
.45 " .54	2	8	10	.77	3.42	4.19	-2.65	.419	-.265
.55 " .64	7	4	11	2.01	1.68	3.69	+.33	.335	+.030
.65 " .84	6	2	8	1.58	.96	2.54	+.62	.318	+.078
.85 " 1.04	2	4	6	.30	.98	1.28	-.68	.213	-.113
1.05 " ∞	4	6	10	1.46	1.56	3.02	-.10	.302	-.010
	78	77	158	27.50	28.41	55.91	-.91	.354	-.006

The systematic errors are more completely eliminated in this table than in Table XVIII. This is shown by the fact that the mean residual, which equals the square root of the sum of the squares of the accidental and systematic errors, is reduced from .374 to .354. The changes of sign are also as frequent as if the errors were wholly accidental. Since the original mean residual was .456, the magnitude of the errors eliminated by the two systems of correction will be $\sqrt{.456^2 - .374^2} = .261$, and $\sqrt{.456^2 - .354^2} = .288$. The accidental error of the difference in magnitude of the two components as estimated and measured is therefore a little more than a third of a magnitude. It appears from Tables XVIII. and XX., that when the components are bright or near together, this deviation is reduced to about one quarter of a magnitude, but becomes nearly half a magnitude for faint or distant stars.

The deviations or errors, which may be denoted by E , are due to several causes.

They consist of the error in the measurements, m , the error, h , due to neglecting the hundredths of a magnitude in the estimate of Struve, and in the application of the two corrections to eliminate systematic error, and finally of the error, s , in the estimates themselves. Since the square of any error is equal to the sum of the squares of all the errors of which it is composed, we shall have $E^2 = m^2 + 3h^2 + s^2$, or $s = \sqrt{E^2 - m^2 - 3h^2}$. The error h enters three times; once in Struve's estimate, and once in applying each of the corrections. If the measurements are free from systematic error, m will be somewhat less than .06, as shown on page 154. The average difference of the measurements of the stars which were repeated was found on page 164 to be about .10. But if the probable error of either value is e , the probable value of their difference will be $\sqrt{2} e$, and the average difference, $\frac{\sqrt{2} e}{.845}$. Since this equals .10, e will equal .059, a confirmation of the value found above. The error due to neglecting the hundredths of a magnitude will vary from .00 to .05; and since the large errors will occur as often as the small, its probable value will equal its mean value or .025. Substituting the mean value of $E = .354$ from Table XX., and assuming that the systematic errors of the estimates of Struve have been completely eliminated, we find $s = \sqrt{(.354)^2 - (.06)^2 - 3(.025)^2} = .346$. The effects of the error in the measurement and in neglecting the hundredths of a magnitude, are therefore almost insensible.

The above discussion affords a means of deducing the true difference in brightness of any of the stars observed by Struve, or of finding the magnitude of the fainter component, if that of the brighter is known.

The rule may be stated as follows: Apply to the fainter component the corrections given on page 185, namely, + 0.1 for magnitudes 1.0 to 5.8; 0.0 for 5.9 to 8.9; -0.1 for 9.0 to 9.7; -0.2 for 9.8 to 10.1; -0.3 for 10.2 to 10.5; and -0.4 for 10.6 to 12.0. If the brighter companion is fainter than 9.0, apply the same corrections to it. Next divide the difference in the uncorrected magnitudes by the distance in seconds, and subtract one-tenth. The difference taken to the nearest tenth will equal the correction for the effect of the bright star, if it does not exceed seven-tenths. Otherwise, the correction will equal seven-tenths. It must be subtracted from the magnitude of the companion after the first correction has been applied. The difference in brightness of the two components will now be given with an average error of about one-third of a magnitude, and it will be sensibly free from systematic error.

ANNALS

OF

THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE.

VOL. XI.—PART II.

PHOTOMETRIC OBSERVATIONS

MADE PRINCIPALLY WITH THE EQUATORIAL TELESCOPE OF FIFTEEN INCHES APERTURE
DURING THE YEARS 1877-79,

BY

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AIDED BY

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PRINTED FROM THE STURGIS FUND.

UNIVERSITY PRESS:
JOHN WILSON AND SON, CAMBRIDGE.
1879.

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PHOTOMETRIC OBSERVATIONS.

PART II.

CHAPTER V.

CONSTANT OF PHOTOMETER D.

A DESCRIPTION of Photometer D has already been given in Part I., page 6. It is there shown that, in order to reduce the observations made with this instrument, we must know the comparative brightness of the images of the same object formed in the large and small telescopes when the Nicols are parallel. The difference of stellar magnitude between these images may be denoted as the constant of the instrument. Let v denote the angle between the Nicols when the images of two objects seen in the large and small telescopes appear equal; v is assumed to be 0° when the light is cut off in the small telescope, or $v = 90^\circ$ when the Nicols are parallel. The amount of light transmitted is proportional to $\sin^2 v$, and the corresponding change in magnitude is $-\frac{2}{0.4} \log \sin v = 5 \log \operatorname{cosec} v$. When $v = 90^\circ$, $\log \operatorname{cosec} v = 0$; hence the difference of magnitude between the images formed by the large and small telescopes is equal to $C + 5 \log \operatorname{cosec} v$. Any observations made with Photometer D may be reduced by this formula, when the constant C has been determined.

To determine C , it is convenient to begin by finding the value of what may be called the equivalent aperture of the small telescope. The word "equivalent" is here used in the same sense as when applied to the disks of planets on page 98. The equivalent aperture of the photometer is therefore the aperture which must be given to a telescope of the ordinary construction, in order that it may form an image of the same brightness as that seen in the photometer when the Nicols are parallel. Represent this aperture by E and the aperture of the large telescope by A . Let L denote the light of the image formed in the large telescope, that formed in the small telescope when the Nicols are parallel being taken as unity. Then $L = \frac{A^2}{E^2}$, since the light is proportional to the square of the apertures. Accordingly, $\log L = 2(\log A - \log E)$ and $C = \frac{\log L}{0.4} = 5(\log A - \log E)$.

An approximate value of the constant C may be obtained by computation. The clear aperture of the small telescope was .63 cms., and this would equal the equivalent aperture but for the loss of light by the prisms. The polarization causes a loss of one-half of the light by total reflection in the first Nicol, and to this must be added the loss by reflection and absorption in passing through the two Nicols and the two reflecting prisms. Assuming, for reasons given on page 2, that ninety per cent of the incident light is transmitted by each prism, the amount transmitted by all will be $.50 \times .90^4 = .328$ of the incident light. Since the light is proportional to the square of the diameter of the object-glass, we shall have $E^2 = .63^2 \times .328$, or $E = .361$. The aperture of the large telescope being 36.60 cms. (see page 200), the constant will equal $5(1.563 + 10.000 - 9.557) = 10.03$.

This value of the equivalent aperture is probably somewhat large, as part of the time the prisms were not exactly in line, so that a portion of the light was cut off. Moreover, the loss of light in a Nicol is generally greater than in a plate of glass, owing to imperfections in the material. Several Nicols were used; some with faces perpendicular to the transmitted rays, others with inclined faces. The loss by reflection from the latter would reduce the equivalent aperture found above. If the inclined faces of the right-angled prisms were greasy, some light would pass through them, although the angle of incidence might be greater than that of total reflection. This also would diminish the equivalent aperture and increase the constant. On the other hand, the loss of light caused by the objectives of the large and small telescopes has been assumed to be equal, and has therefore been neglected in the formula for finding C from E . The greater opacity of the large lens would be equivalent to a reduction of its aperture, and hence would lessen the value of the constant, and reduce the source of error just mentioned.

Three experimental methods have been employed for determining the constant. In each of these, images of the same object were formed by the photometer and large telescope. The image in the latter was then reduced by a known amount until it was fainter than the image formed by the photometer when $v = 90^\circ$. The Nicol was turned until the images were equal and the corresponding value of v recorded. In the first method, the object selected was one of the brighter planets. Its light was reduced in the large telescope by inserting in the focus a plate pierced with a minute circular hole, through which the planet was allowed to shine. The diminution in light in this case was proportional to the squares of the diameters of the hole and image of the planet. As the latter was still somewhat too bright, a further diminution was effected by reducing the aperture of the large telescope by diaphragms. Let A denote the aperture used, expressed in centimetres, H and P the diameters of the hole and planet in seconds of arc, and I the light of the image of the planet formed by a tele-

scope having an aperture of one centimetre. Then, since the light is proportioned to the square of the aperture, $l A^2$ will be the light of the image of the entire planet formed in the large telescope. The portion of this passing through the hole will equal $l A^2 \frac{H^2}{P^2}$. By the definition of E , the light passing through the small telescope when the Nicols are parallel is $l E^2$, and when the angle of the Nicols is v , it is $l E^2 \sin^2 v$. The observations give such a value of v that these quantities are equal, or $l A^2 \frac{H^2}{P^2} = l E^2 \sin^2 v$, and hence $E = \frac{A H}{P \sin v}$.

The result of the measurements made by this method are given in Table XXI. The first three columns give a number for reference, the number of the set in Table I., and the date. The next four columns give the designation of the hole and its diameter in seconds of arc, the initial of the planet, and its equivalent diameter, or the diameter of a circular disk having an area equal to that of the planet. The description of the holes and the measures of their diameters will be found in Appendix B. The equivalent diameters of the planets are found as in Chapter III., page 98. The eighth column gives the aperture of the large telescope. This was reduced by two diaphragms from 36.60 to 12.70, or 7.65 cms. The next column gives the logarithm of the aperture, multiplied by the diameter of the hole, and divided by the diameter of the planet. The tenth column gives the mean reading, and the eleventh the logarithm of its sine. The logarithm of the equivalent aperture is the difference of the ninth and eleventh columns, and is given in the twelfth column. The corresponding equivalent aperture is given in the next column. This is followed by the constant, which is found by subtracting the logarithm of the equivalent aperture from the logarithm of the full aperture of the large telescope, and multiplying the result by five to reduce it to magnitudes. The deviation of the constant from its mean value of 10.48 is given in the last column but one. The last column gives the initial of the observer.

The first and second sets of this Table must be rejected, since they lead to the absurd result that the equivalent aperture is greater than the clear aperture of the telescope. In other words, the Nicols increase rather than diminish the light! Probably the name of the hole was recorded incorrectly, or the image of the planet did not cover the hole.

In set 9, the observer estimated the reflected image as no brighter than that seen through the hole, whatever the position of the circle. No settings could therefore be made, but there seemed to be no reason why as much weight should not be given to this estimate as to the others. The value corresponding to a reading of 90° has therefore been computed and employed in finding the mean.

Sets twenty-two to twenty-five are also open to criticism. The record gives the hole as R 1, which has a diameter of $1''.069$. But this would give an equivalent

aperture of more than a centimetre, and would require that the observations should be rejected. The mean of the remaining values of the constant is 10.55. It seems more probable that the same hole was used as in the other observations, and in the computations the diameter of R 3 has been employed.

TABLE XXI.

CONSTANT OF PHOTOMETER D BY OBSERVATION OF PLANETS THROUGH MINUTE HOLES.

No.	No. in Table I.	Date. 1877.	Hole.		Planet.		Apert.	Log $\frac{A}{P}$	Reading.	Log sin Reading.	Log E .	E .	Const.	Resid.	Obs.
			Design.	Diam.	Init.	Diam.									
1	137	Sept. 4	J 1.	.760	M.	26.8	36.60	0.017	13.62	9.372	0.645	4.42	[4.60]		P.
2	138	" "	"	"	M.	"	"	"	12.62	9.339	0.678	4.76	[4.43]		P.
3	153	Sept. 9	Q 1.	.390	J.	38.3	12.70	9.112	30.81	9.709	9.403	.25	10.80	+.32	P.
4	154	" "	"	"	J.	"	"	"	23.43	9.600	9.512	.33	10.25	-.23	P.
5	155	" "	"	"	M.	26.6	"	9.270	37.23	9.782	9.488	.31	10.37	-.11	P.
6	156	" "	"	"	M.	"	"	"	30.85	9.710	9.560	.36	10.01	-.47	P.
7	157	" "	"	"	M.	"	"	"	39.69	9.805	9.465	.29	10.49	+.01	P.
8	164	" "	"	"	M.	"	"	"	42.19	9.827	9.443	.28	10.62	+.14	P.
9	—	" "	"	"	M.	"	"	"	90.+	0.000	9.270	.19	11.46	+.98	S.
10	165	" "	"	"	M.	"	"	"	31.65	9.720	9.550	.35	10.06	-.42	P.
11	170	Sept. 10	"	"	M.	26.5	7.65	9.052	25.99	9.642	9.410	.26	10.76	+.28	P.
12	171	" "	"	"	M.	"	"	"	39.65	9.805	9.247	.18	11.58	+1.10	P.
13	173	Sept. 11	"	"	J.	38.1	"	8.894	19.90	9.532	9.362	.23	11.00	+.52	P.
14	174	" "	"	"	J.	"	"	"	18.15	9.493	9.401	.25	10.81	+.33	P.
15	176	" "	"	"	M.	26.4	"	9.053	19.90	9.532	9.521	.33	10.21	-.27	P.
16	177	" "	"	"	M.	"	"	"	21.45	9.563	9.490	.31	10.36	-.12	P.
17	178	" "	"	"	M.	"	"	"	26.62	9.651	9.402	.25	10.80	+.32	S.
18	183	Sept. 12	R 3.	.363	M.	26.3	"	9.024	20.08	9.536	9.488	.31	10.12	-.36	P.
19	184	" "	"	"	M.	"	"	"	15.78	9.434	9.590	.39	9.86	-.62	P.
20	185	" "	"	"	M.	"	12.70	9.244	50.29	9.886	9.358	.23	11.02	+.54	S.
21	191	" "	"	"	M.	25.4	"	9.259	27.74	9.668	9.591	.39	9.86	-.62	P.
22	192	Sept. 13	R 1.	"	J.	37.9	"	9.085	21.75	9.568	9.517	.33	10.23	-.25	P.
23	193	" "	"	"	J.	"	"	"	21.73	9.568	9.517	.33	10.23	-.25	P.
24	194	" "	"	"	M.	25.2	"	9.263	28.17	9.674	9.589	.39	9.86	-.62	P.
25	195	" "	"	"	M.	"	"	"	26.26	9.645	9.619	.42	9.72	-.76	P.
26	229	Sept. 19	R 3.	"	J.	37.3	"	9.092	31.48	9.718	9.374	.24	10.94	+.46	P.
27	230	Sept. 22	"	"	J.	37.0	7.65	8.876	17.19	9.471	9.405	.25	10.79	+.31	P.
28	231	" "	"	"	J.	"	"	"	15.54	9.428	9.448	.28	10.57	+.09	P.
29	232	" "	"	"	M.	24.7	"	9.051	16.50	9.453	9.598	.40	9.82	-.66	P.
30	233	" "	"	"	M.	"	"	"	24.95	9.625	9.426	.27	10.68	+.20	S.
31	234	" "	"	"	M.	"	"	"	21.82	9.570	9.481	.30	10.41	-.07	P.
32	235	" "	"	"	M.	"	"	"	25.11	9.628	9.423	.26	10.70	+.22	S.
													10.48	±.39	

The variations in the last column are partly real changes in the constant, and partly due to errors of observation. Since the telescope was used for micrometric as well as photometric observations, the photometer had to be taken to pieces and detached every evening. The adjustments were therefore entirely altered, and the amount of light intercepted by the prisms was likely to alter from day to day. Moreover the instrument being new, efforts were continually made to improve its action. Various prisms

were tried, and at one time the Nicols were replaced by double-image prisms. Frequent changes in the constant were therefore to be expected, which were further demonstrated by the observations of September 12 and 13. On these days the constants had their smallest values; and it will be found that the measurements made with the photometer of both the satellites of Mars attain their smallest values on these days, as should be the case when the constant has diminished.

Although frequently mounting and dismounting the instrument materially increased the time required for the observations, and rendered the values of the constant less accordant, yet it insured one important advantage; it increased the independence of the observations, and rendered less probable the existence of a large constant error in all.

In the second method of determining the constant, the image formed by the large telescope is reduced by replacing its objective by a lens of short focus, having an aperture of only a fraction of a centimetre. The equivalent aperture is determined as in the first method, except that as the light is reduced wholly by diminishing the aperture A , the terms H and P are omitted. We therefore have $E = \frac{A}{\sin v}$. Table XXII. gives the results of the measurements, the various columns having the same meaning as in Table XXI. except that $\log \frac{A H}{P}$ is replaced by $\log A$, and the columns giving the names and diameters of the holes and planets are omitted.

TABLE XXII.

CONSTANT OF PHOTOMETER D BY OBSERVATION OF ARTIFICIAL STARS.

No.	No. in Table I.	Date. 1877.	Apert.	Log A .	Reading.	Log sin Reading.	Log E .	E .	Constant.	Resid.	Obs.
1	143	Sept. 4	.134	9.127	33.14	9.738	9.389	.24	10.87	+ .06	P.
2	144	" "	"	"	63.34	9.951	9.176	.15	11.93	+ 1.12	S.
3	145	Sept. 5	"	"	46.25	9.859	9.268	.19	11.47	+ .66	P.
4	146	Sept. 6	"	"	31.35	9.716	9.411	.26	10.76	- .05	P.
5	147	" "	"	"	33.74	9.745	9.382	.24	10.90	+ .09	P.
6	148	" "	"	"	32.15	9.726	9.401	.25	10.81	.00	P.
7	149	" "	"	"	22.19		9.365	.23	10.99	+ .18	P.
8	150	" "	.94	9.973	24.61		9.483	.30	11.40	+ .59	P.
9	151	" "	"	"	40.06		9.747	.56	9.08	- 1.73	P.
10	152	" "	"	"	30.22		9.587	.39	9.88	- .93	P.
									10.81	± .54	

The source of light employed in the first experiments of this Table was the clouded sky viewed in a darkened room through a small hole in a piece of cardboard placed over an aperture in one of the shutters. It was apprehended, however, that some polarized light might thus be admitted from spaces between the clouds. Accordingly, the source of light employed in the observations of Sept. 6, 1877, was a lantern placed

behind a piece of cardboard pierced with a small hole. A possible source of error here is, that the objects viewed by the two telescopes may not be of strictly equal brightness; and, on this account, in most of the similar work done later, the lamplight was transmitted by a lens.

The last four sets of Table XXII. were obtained by comparing the images formed by inserting Photometer C in the eye-piece. The Nicols were first set parallel, and Photometer C was then turned until one of the images of the star seen through the auxiliary telescope and Nicols disappeared. The planes of its double-image prisms were then parallel, and perpendicular to the Nicols. The remaining image was then compared by Photometer C with one of the images of the artificial star seen through the principal telescope. Since in Photometer C it makes no difference which image is brightest, the full aperture of the small telescope of .94 cms. was used in the last three sets. Number nine was marked at the time as erroneous and to be rejected. The indirectness of this measurement is a serious objection to it.

The small values of sets 9 and 10 are perhaps due to the large emergent pencil. As this had a diameter of .53 cms., it may have been in part cut off by the edge of the pupil, which must have been partially contracted, since the observations were made in the daytime. If sets 7 to 10 are omitted, the mean becomes 11.12 instead of 10.81, and the average deviation .38 instead of .54.

In the third method of determining the constant, the telescope is turned towards the sky when overcast, and the brightness of the portion of the field seen in the photometer is reduced, by turning the Nicol, to equality with the part of the field formed by the large telescope. In making these measurements, it was necessary first to reduce the aperture of the large telescope, and to make the observations only on cloudy days, to avoid an error due to the polarization of the air when the sun is shining upon it.

The brightness of a surface seen in a telescope is proportional to the square of the angular aperture of the object-glass, or its aperture divided by the focal length. Calling F, f the focal lengths of the large and small telescopes, the brightness of the field of the former may be measured by $\frac{A^2}{F^2}$, and that of the latter by $\frac{E^2}{f^2}$, when the Nicols are parallel. When inclined at an angle v , the light will be reduced to $\frac{E^2}{f^2} \sin^2 v$. If such a value is given to v that the two halves of the field will be equally bright, $\frac{E^2}{f^2} \sin^2 v = \frac{A^2}{F^2}$, or $E = \frac{A f}{F \sin v}$. The same diaphragms were used as in the first method; F will be assumed equal to 682.8 and f equal to 7.036, as the result of measures described in Appendix E.

The various determinations of the constant by this method are given in Table XXIII.

The columns are the same as in the last table, except that in the fifth column $\log \frac{Af}{F}$ is given instead of $\log A$.

TABLE XXIII.

CONSTANT OF PHOTOMETER D BY OBSERVATION OF LIGHT OF CLOUDS.

No.	No. in Table I.	Date. 1877.	Apert.	$\log \frac{Af}{F}$	Reading.	$\log \sin$ Reading.	$\log E$.	E .	Constant.	Resid.	Obs.
1	225	Sept. 18	12.70	9.117	34.05	9.748	9.369	.23	10.97	— .20	P.
2	226	Sept. 19	"	"	36.09	9.770	9.347	.22	11.08	— .09	S.
3	227	" "	"	"	32.03	9.725	9.392	.25	10.85	— .32	P.
4	228	" "	"	"	35.92	9.768	9.349	.22	11.07	— .10	S.
5	284	Sept. 27	"	"	41.44	9.821	9.296	.20	11.33	+ .16	P.
6	285	" "	"	"	39.65	9.805	9.312	.21	11.25	+ .08	P.
7	286	" "	7.65	8.897	24.06	9.610	9.287	.19	11.38	+ .21	P.
8	287	" "	"	"	24.91	9.625	9.272	.19	11.45	+ .28	P.
									11.17	± .18	

On September 18–19, the sun shone feebly through the clouds, but no polarization was perceptible with a Nicol and plate of unannealed glass. On September 27, the sky was completely clouded.

A fourth method of determining the constant experimentally consisted in the measurement with Photometer D of objects whose true brightness was afterwards determined with another instrument. Some of the satellites of Saturn were used for this purpose, their light being found from the observations given in Chapter IX.

In Table XXIV., the first three columns give the number for reference, the number in Table I., and the date. The next column gives the name of the satellite observed, and the planet with which it was compared. The fifth column gives the assumed difference in stellar magnitudes of the satellite and Saturn, not including the effect of the ring. These values are taken from Chapter IX. The sixth column supplies the correction to be added to the fifth column to give the true difference in brightness between the satellite and the planet observed. In the case of Mars, this correction is deduced from the mean albedo, the light ratio, and the altitudes of Mars and Saturn, as on page 100. In the case of Saturn, the correction relates only to the ring, and is found as on page 99. The seventh column gives the mean reading, and the eighth five times its logarithmic cosecant. This equals the observed difference in magnitudes of Saturn as seen in the small telescope, and the satellite as seen in the large telescope. The difference in light of the planet and satellite will equal the sum of the fifth and sixth columns, as determined by computation, or it will equal the unknown constant *plus* the eighth column, as found by observation. The constant given in the ninth column will accordingly be found by subtracting the amounts given in the eighth column from the

sum of the corresponding quantities in the fifth and sixth columns. The mean of all its values is 10.66, and the residuals from this mean are given in the tenth column. The last column gives the initial of the observer.

TABLE XXIV.

CONSTANT OF PHOTOMETER D BY OBSERVATIONS OF THE SATELLITES OF SATURN.

No.	No. in Table I.	Date. 1877.	Objects.	Diff. in Magn. Table LII.	Correc- tion.	Reading.	Obsd. Diff. in Magn.	Constant.	Resid.	Obs.
1	181	Sept. 11	Tethys, Saturn . .	10.46	.10	62.05	.27	10.29	-.37	P.
2	182	" "	" " . .	"	"	60.25	.31	10.25	-.41	P.
3	196	Sept. 13	Enceladus, Saturn .	11.40	"	34.87	1.22	10.28	-.38	P.
4	197	" "	" " . .	"	"	31.14	1.43	10.07	-.59	S.
5	247	Sept. 23	Rhea + Dione, Mars	—	—	19.22	—	—		P.
6	248	" "	" " " "	"	"	19.89	"	"		S.
7	249	" "	Tethys, Mars . . .	10.46	3.16	17.96	2.55	11.07	+.41	P.
8	250	" "	" " . . .	"	"	15.67	2.84	10.78	+.12	S.
9	256	Sept. 24	Iapetus, Mars . . .	—	—	15.53	2.86	—		P.
10	257	" "	Titan, Mars . . .	8.50	3.16	45.72	.23	11.43	+.77	P.
11	258	" "	Tethys, Mars . . .	10.46	"	13.99	3.08	10.54	-.12	P.
12	259	" "	Enceladus, Mars . .	11.40	3.15	7.43	4.44	10.11	-.55	P.
13	260	" "	Rhea, Mars . . .	9.88	"	22.74	2.06	10.97	+.31	P.
14	261	" "	Dione, Mars . . .	10.57	"	17.34	2.63	11.09	+.43	P.
15	262	" "	Tethys, Mars . . .	10.46	"	15.17	2.91	10.70	+.04	P.
16	263	" "	" " . . .	"	"	13.66	3.13	10.48	-.18	S.
17	264	" "	Titan, Mars . . .	8.50	"	33.97	1.26	10.39	-.27	P.
18	265	" "	" " . . .	"	"	35.08	1.20	10.45	-.21	S.
19	266	" "	Iapetus, Mars . . .	—	—	15.46	2.87	—		P.
20	267	" "	" " . . .	"	"	16.51	2.73	"		S.
21	276	Sept. 25	Tethys, Mars . . .	10.46	3.14	16.36	2.75	10.85	+.19	P.
22	277	" "	" " . . .	"	"	16.42	2.74	10.86	+.20	S.
23	278	" "	Rhea, Mars . . .	9.88	"	20.94	2.23	10.79	+.13	P.
24	279	" "	" " . . .	"	"	25.20	1.85	11.17	+.51	S.
								10.66	±.33	

The observations of the variable satellite Iapetus, and of the combined light of Rhea and Dione have been retained in the table for the sake of completeness, but have not been used in determining the constant, since errors were apprehended from the indirectness of the reduction in these cases.

Besides the above, two or three other methods of determining the constant were attempted, but they were given up from their indirectness, and the consequent uncertainty of the results. It is only necessary to use any means for reducing the image of an object seen in the large telescope until it is fainter than that in the small telescope, if the amount of the reduction can be determined with accuracy. A simple diaphragm cannot be used for this purpose, because the images are then greatly enlarged by diffraction, so that they cannot be accurately compared with the minute points of light formed by the small telescope. An attempt was made to reduce the light by a shade-

glass, but the opacity appeared to vary in different portions of the same sheet. A better method seemed to be to insert a plate of glass with inclined sides, or, better, an achromatic prism of small angle, and compare the faint images formed by internal reflection with that in the small telescope. An uncertainty, however, arises in the amount of the reduction thus produced. If the glass is perfectly transparent, clear, and polished, and has an index of refraction of 1.5, the various images would have a brilliancy of .922, .00147, .00000236, .00000000377, &c., that of the original image being 1.00. A star will accordingly be reduced in brightness about one-tenth of a magnitude, and will appear attended by a series of faint companions, each of which will be about seven magnitudes fainter than its predecessor. The first and second of these companions were clearly seen with a first magnitude star.

Before comparing the results of the measurements given above, it is important to consider the advantages of each method, and the errors to which it is subject. The comparison by the aid of minute holes has the important advantage that it may be made under very nearly the same conditions as the photometric measurement. The error due to the observer, or his personal equation, is therefore likely to be small. On the other hand, a very minute particle of dust might reduce the size of the hole, and thus give too small a value to the constant. Owing to the varying brightness of different parts of the disk of the planet, an error may be caused if the portion shining through the hole does not represent the average brightness of the entire disk. In some cases, this error was reduced by moving the telescope a little after each setting; but in general the slight irregularities in the running of the driving-clock effected the same object. The disk of a planet will always look too large for three reasons; the irradiation of the eye, the defects of the object-glass, and the unequal refraction of the air. The first of these causes can do no harm, since it will not affect the proportion of the light which will pass through the hole. The diffraction and aberrations of the objective will enlarge every point of the planet into a disk. If the effect is slight, the brightness of the centre of the planet will not be altered, owing to the superposition of the images. The true edge of the disk will, however, have only one-half the brightness of the central portion, the light increasing from it towards the centre, and diminishing outwards over a distance equal to one-half of the enlargement caused by the objective. Accordingly, if the hole is placed near the centre of the disk, no error will be caused by the objective; but on the other hand, the irregularities in brightness of different portions of the planet will be to a certain extent neutralized. If the hole is placed near the edge, too little light will pass through it, and the resulting value of the constant will be too small. The varying density of the air acts in two ways; first, by making objects appear in constant motion, and secondly, by enlarging every point into a disk. The motion does no harm, unless it is sufficient to move the brightest

portion of the disk away from the hole. The enlargement produced by the air combines with the defects of the objective in increasing the size of the disk of the planet.

Unless the disk of the planet is large, it is often difficult to find the hole, and to be sure that it is properly placed. The uncertainty in the diameter of Mars, already noticed on page 99, is liable to cause an error in observations with this planet. If the mean diameter is taken $11''.10$, all the values of the constant found above by the aid of this planet should be increased by $.20$. If the diameter is $9''.4$, the constant should be diminished by $.16$.

The advantages of the second method of determining the constant experimentally, are, first, the accuracy with which the reduction may be measured, and secondly, that the observation may be made at any convenient time and place. The objections are, that, as the large telescope is not used, its errors are not eliminated; and as the photometer must be readjusted after removing it, the same portion of the light may not be transmitted by the prisms.

The third method gives more accordant results than either of the others. The principal criticism that can be made to it is, that the observations are of a different character from those of a star, surfaces instead of points being compared. The personal equation of the observer will not therefore be eliminated.

The fourth method of determining the constant possesses most of the advantages of the first method without its defects. It eliminates the errors due to the instrument, and makes the measurements depend on a long series of observations made later, when the observers had acquired greater skill in the use of these instruments.

The results of these various methods are given in Table XXV. The successive columns give a current number, the method employed, the number of separate values from which the mean value given in the fourth column is deduced, the average deviation of these values from the mean, and their residuals from the value adopted.

TABLE XXV.
COMPARISON OF DETERMINATIONS OF CONSTANT OF PHOTOMETER D.

No.	Method.	No. Sets.	Constant.	Av. Dev.	Resid.
1	Theoretical	—	10 +	—	
2	I. Minute Holes	32	10.48	.39	— .22
3	II. Artificial Stars . . .	10	10.81	.54	+ .11
4	III. Sky	8	11.17	.18	+ .47
5	IV. Satellites of Saturn	19	10.66	.33	— .04
6	Mean of Four Methods .	4	10.78	.21	+ .08
7	Mean by Weights . . .	4	10.66	.17	— .04
8	Adopted Constant . . .	—	10.70	—	

From the uncertainty regarding the amount of light cut off by the prisms, the theoretical value only gives an inferior limit to the constant, and shows that its value must exceed 10.00. The four experimental methods may be combined in two ways. We may assume that the accidental errors are practically eliminated, that the differences are due to unknown sources of systematic error, and that each method is equally likely to be correct. In this case we must take the mean 10.78, from which the separate results differ on the average .21. If we regard the differences as merely due to accidental errors, we must give each of the methods a weight proportional to the number of sets. This gives the result 10.66, with an average deviation of .16. If we take the mean of the 69 values of the constant given by the four methods, we obtain the same value.

It is evident that the observations will not serve to determine the constant within several hundredths of a magnitude, but that it probably does not differ much from 10.70. This value will therefore be used in the reductions of the observations made with Photometer D. It will be noticed that it does not differ sensibly from the value 10.66, deduced by the fourth and best method of determining the constant. Most of the errors to which the first method is subject, tend to make the constant too small, as has been shown above. This probably accounts for the small value 10.48.

In using this photometer, and also those described in the next chapter, care must be taken that the emergent pencils of the large and small telescopes coincide. This adjustment is made by removing the eye-piece *A*, Figs. 4, 5, and 6, and turning the prism *F* until the reflection of the small objective in it appears to be concentric with that of the large telescope. At night the objectives may be illuminated by throwing the light of a lantern into them, or by bringing a bright star into the field of each. When using the instrument, focus the eye-piece on the edge of the prism *F*, and turn the prism *B* until the end of the large telescope, illuminated, if necessary, by artificial light, is seen reflected into the field of the small telescope. The faint star is then brought into the field of the large telescope, and if the bright star is sufficiently near, its image in the prism *F* will be seen near the image of the end of the telescope; if the bright star is not near, it must be found by turning or inclining the prism *B*. In this case it is not always easy to identify the required star, but the operation is facilitated by the low power and large field of the small telescope. After finding the bright star, it may be brought into good focus by moving the objective *D*. The image of the faint star is brought to a focus by moving the whole photometer. The two images may then be placed side by side at equal distances from the edge of the prism, and rendered equal by turning the circle *G* of Photometer D or the screw *I* of the other photometers.

CHAPTER VI.

CONSTANTS OF PHOTOMETERS E, G, I, E', AND J.

IN these instruments, as has been shown on page 7, the light is varied by a screw, which alters the aperture of the auxiliary telescope. The reading of the screw when the aperture is reduced until all the light is cut off, is called the zero of the instrument. The constant is the difference in magnitude of the images of a star, formed by the large telescope and by the photometer, when the screw is turned one complete revolution from the zero. This position, therefore, corresponds to that in which the Nicols are parallel in Photometer D. The variation in the light will be proportional to the square of the corrected reading, or difference between the observed reading and the zero. With these changes, the methods of determining the constant of Photometer D may be applied directly to Photometer E. Calling r the corrected reading, it is only necessary to substitute r for $\sin v$. The difference in stellar magnitudes of the images in the large and small telescopes corresponding to any reading, r , will accordingly equal $C - 5 \log r$. In all cases, if r is less than unity, the characteristic of its logarithm becomes negative; and if it is increased by 10 as usual, the required difference of magnitude is evidently equal to $C - 5 \log r + 50$.

In this form of photometer, an accurate value of the constant may be obtained by computation. Were it not for the loss of light by the prisms, the equivalent aperture would equal the diameter of a circle, having an area equal to that of the aperture of the small telescope when the screw has been turned exactly one revolution from the zero. It is shown in Appendix C that in Photometer E this area equalled .00528 cms.² on October 1, and .00514 cms.² after that date. These areas correspond to circles having diameters of .0820 and .0809 cms. Since the aperture of the large telescope was 36.60 cms., the corresponding constants are, $5 (1.563 + 10.000 - 8.914) = 13.24$, and $5 (1.563 + 10.000 - 8.908) = 13.28$.

Assuming that ninety per cent of the light is transmitted by each of the prisms, a star will from this cause be reduced in brightness .114 magnitudes by each prism, or .23 by both. The constants must accordingly be increased by this amount, which gives 13.47 for October 1 and 13.51 after that date. We here assume that the absorption caused by the objective of the small telescope is compensated by the loss from the objective of the large telescope.

The value in cms.² of the area of the aperture of Photometers G and I is shown in Appendix C to be .0506 S^2 . The aperture of the large telescope should be taken at 37.95 instead of 36.60, since during November, 1877, a diaphragm cutting off a portion of the aperture was removed. With these values the equivalent aperture becomes .254 cms., and the constant $5(1.579 + 10.000 - 9.405) = 10.87$. Adding .23 for the absorption of the prisms, gives 11.10 for the constant of Photometers G and I.

The constant of Photometer E' may be determined directly from that of Photometer E. The instruments differ only in the reflector near the eye-piece. The right-angled prism of E is replaced in E' by a plate of glass. The image formed by the small telescope will be reduced .11 of a magnitude by the reflecting prism, and will undergo a much greater reduction by reflection from the plate of glass. By Fresnel's formula .0573 of the light will be reflected from the first surface of the plate, if the index of refraction is taken as 1.55, when the angle of incidence is 45°. (See Proc. Amer. Acad. ix. 4.) The same fraction of the transmitted portion will be reflected at the second surface; accordingly, the reflected portion of the whole light will be $(1 - .0573) \times .0573 = (.9427) \times .0573 = .0540$. The second passage of this light through the first surface will again reduce it in the same proportion, so that the image formed by it will have a brightness of $.9427^2 \times .0573 = .0509$. By successive internal reflections other images will be formed having a brightness $.9427^2 \times .0573^3 = .0001673$, $.9427^2 \times .0573^5 = .000000549$, &c. The reduction in magnitudes of the light forming these images will equal 3.10, 3.23, 9.44, and 15.65. The first and second images appear of nearly equal brightness; the third image noticed in the case of Venus and other bright objects appears as a faint star. The other images, each of which is 6.21 magnitudes fainter than that preceding it, are visible only with the Sun or other exceedingly bright object. Although the faces of the glass are parallel, these images are not superposed, since the beam of light is convergent. The images will not have the same focus, owing to the difference in length of the path traversed by the light; ordinarily this effect is not noticeable.

The image formed by the large telescope also suffers loss by transmission through the reflecting plate. A series of images are formed having brightnesses of $.9427^2 = .889$, $.9427^2 \times .0573^2 = .00292$, $.9427^2 \times .0573^4 = .00000958$, &c. The corresponding reductions in magnitudes will equal .13, 6.34, 12.55, &c.

If there was no loss of light, the constant of Photometer E', like that of E, would equal 13.28. This must be increased by the loss of light of the image formed by the small telescope, and diminished by the loss of the image of the large telescope. The first reflected image suffers a loss of .11 by the prism, and of 3.10 by the plate of glass. The image in the large telescope is reduced by .13. Accordingly the constant for the first image will equal $13.28 + .11 + 3.10 - .13 = 16.36$. The constant for the second

image in like manner will equal $13.28 + .11 + 3.24 - .13 = 16.50$. As the difference in these images was barely perceptible, and when noticed the brighter one was used as a standard, the value 16.40 may be adopted as the theoretical constant of this instrument.

The constant of Photometer J may be found in the same way. For the first image we have, $10.87 + .11 + 3.10 - .13 = 13.95$, and for the second, $10.87 + .11 + 3.24 - .13 = 14.09$. The value 14.00 may therefore be taken as the theoretical constant of Photometer J.

The constant of Photometer E, like that of Photometer D, was measured experimentally by minute holes, by an artificial star, and by the light of the sky. The results are given in Tables XXVI., XXVII., and XXVIII. The columns have the same meanings as in Tables XXI., XXII., and XXIII., except that the reading of the zero-point is subtracted from the observed reading, and the logarithm of the remainder is substituted for the logarithm of the sine of the reading. As is shown in Appendix D, the reading of the zero-point was 14.74, except on November 19 and 20, when 14.67 is assumed as the zero.

TABLE XXVI.

CONSTANT OF PHOTOMETER E BY OBSERVATION OF PLANETS THROUGH MINUTE HOLES.

No.	No. in Tab. I.	Date. 1877.	Hole.		Planet.		Apert.	$\text{Log } \frac{AH}{P}$	Read.	Log Read.	Log E.	E.	Const.	Resid.	Obs.
			Desig.	Diam.	Init.	Diam.									
1	402	Oct. 13	R 3	0.363	S.	18.8	36.60	9.849	7.66	0.884	8.965	.092	13.00	+.04	P.
2	407	" "	"	"	S.	"	"	"	7.93	0.899	8.950	.089	13.06	+.11	U.
3	443	Oct. 17	"	"	S.	18.9	"	9.847	7.82	0.893	8.954	.090	13.04	+.09	P.
4	444	" "	"	"	S.	"	"	"	7.63	0.882	8.965	.092	12.99	+.04	U.
5	448	Oct. 18	"	"	M.	19.1	"	9.842	8.37	0.923	8.919	.083	13.22	+.27	P.
6	449	" "	"	"	M.	"	"	"	7.67	0.885	8.957	.091	13.03	+.08	U.
7	450	" "	"	"	S.	18.9	"	9.847	8.26	0.917	8.930	.085	13.16	+.21	P.
8	544	Nov. 7	"	"	M.	15.0	"	9.947	7.69	0.886	9.061	.115	12.51	-.44	P.
9	545	" "	"	"	M.	"	"	"	2.38	0.377	9.570	.372	[9.96]		S.
10	546	" "	"	"	M.	"	"	"	8.55	0.932	9.015	.104	12.74	-.21	U.
11	547	" "	"	"	M.	"	"	"	8.54	0.931	9.016	.104	12.73	-.22	P.
													12.95	±.17	

In Table XXVI., set 9 has not been retained in taking the mean. The reading is so much less (corresponding to less than one-tenth of the light) than the observations immediately preceding and following it, that it is probable that the wrong hole was observed, or that the image of the planet was incorrectly placed. This is not surprising, as it is a matter of no little difficulty to bring the planet into the proper position. If set 9 is retained, the mean becomes 12.68, all the residuals but two become positive, and their average value becomes .52.

TABLE XXVII.

CONSTANT OF PHOTOMETER E BY OBSERVATION OF ARTIFICIAL STARS.

No.	No. in Tab. I	Date. 1877.	Aperture.	Log A.	Reading.	Log Reading.	Log E.	E.	Constant.	Residuals.	Obs.
1	355	Oct. 8	.8173	9.912	12.02	1.080	8.832	.068	13.65	— .09	P.
2	356	" "	"	"	11.15	1.047	8.865	.073	13.49	— .25	S.
3	357	" "	"	"	12.74	1.105	8.807	.064	13.78	+ .04	S.
4	358	Oct. 9	"	"	12.98	1.113	8.799	.063	13.82	+ .08	U.
5	359	" "	"	"	13.85	1.141	8.771	.059	13.96	+ .22	U.
6	360	" "	"	"	13.02	1.114	8.798	.063	13.82	+ .08	P.
7	361	" "	"	"	12.89	1.110	8.802	.063	13.80	+ .06	P.
8	362	" "	"	"	9.85	0.993	8.919	.083	13.22	— .52	S.
9	363	" "	"	"	11.09	1.045	8.867	.074	13.48	— .26	S.
10	364	" "	.2467	9.392	3.75	0.574	8.818	.066	13.72	— .02	P.
11	365	" "	"	"	3.80	0.580	8.812	.065	13.75	+ .01	P.
12	366	" "	"	"	4.32	0.635	8.757	.057	14.03	+ .29	S.
13	367	" "	"	"	4.32	0.636	8.756	.057	14.04	+ .30	S.
14	368	" "	"	"	3.68	0.566	8.826	.067	13.68	— .06	P.
15	369	" "	"	"	3.78	0.577	8.815	.065	13.74	.00	P.
16	370	" "	"	"	3.58	0.554	8.838	.069	13.63	— .11	S.
17	371	" "	"	"	3.71	0.569	8.823	.067	13.70	— .04	S.
18	372	" "	"	"	3.90	0.591	8.801	.063	13.81	+ .07	U.
19	373	" "	"	"	4.00	0.602	8.790	.062	13.86	+ .12	U.
20	615	Nov. 15	.725	9.860	11.78	1.071	8.789	.062	13.87	+ .13	P.
21	616	" "	"	"	13.68	1.136	8.724	.053	14.19	+ .45	S.
22	617	" "	"	"	12.36	1.092	8.768	.059	13.97	+ .23	P.
23	618	" "	"	"	12.87	1.110	8.750	.056	14.06	+ .32	S.
24	619	" "	"	"	12.34	1.091	8.769	.059	13.97	+ .23	U.
25	620	" "	"	"	10.06	1.002	8.858	.072	13.52	— .22	P.
26	621	" "	"	"	10.33	1.014	8.846	.070	13.58	— .16	S.
27	622	" "	.309	9.490	4.17	0.620	8.870	.074	13.46	— .28	P.
28	623	" "	"	"	4.15	0.618	8.872	.074	13.45	— .29	S.
29	624	" "	"	"	4.24	0.627	8.863	.073	13.50	— .24	P.
30	625	" "	"	"	4.35	0.638	8.852	.071	13.55	— .19	S.
									13.74	± .18	

In the observations of Oct. 8–9, 1877, of Table XXVII., the object observed was lamplight transmitted by a detached eye-piece. After the first nine sets, the aperture of the telescope used to replace the East Equatorial was reduced, and a larger lens used to transmit the lamplight, forming a brighter artificial star.

In the first two sets of November 15, the object observed was the light of the sky, as in the first observations with Photometer D. In this case, there was no risk of error from polarization of the light, but the images seen with the two telescopes might differ in brightness. In the next three sets, the hole was covered with oiled paper; and afterwards, the light employed was that of a lantern shining on a quartz sphere placed behind a hole in cardboard. Two images were thus formed in each telescope, one brighter than the other. Both were considered in making the comparisons.

TABLE XXVIII.

CONSTANT OF PHOTOMETER E BY OBSERVATION OF SKY.

No.	No. in Tab. I.	Date. 1877.	Apert.	Log $\frac{Af}{F}$	Reading.	Log Reading.	Log E.	E.	Constant.	Resid.	Obs.
1	351	Oct. 8	36.60	0.102	17.70	1.248	8.854	.071	13.54	.00	P.
2	352	" "	12.70	9.643	5.76	0.760	8.883	.076	13.40	-.14	P.
3	353	" "	"	"	5.40	0.732	8.911	.081	13.26	-.28	P.
4	473	Oct. 23	"	"	5.99	0.777	8.866	.073	13.48	-.06	P.
5	496	Oct. 24	"	"	5.62	0.750	8.893	.078	13.35	-.19	P.
6	497	" "	"	"	6.93	0.841	8.802	.063	13.80	+.26	U.
7	498	" "	"	"	5.73	0.758	8.885	.077	13.39	-.15	P.
8	499	Oct. 25	"	"	5.78	0.762	8.881	.076	13.41	-.13	P.
9	500	" "	"	"	7.12	0.852	8.791	.062	13.86	+.32	U.
10	501	" "	7.65	9.423	3.77	0.576	8.847	.070	13.58	+.04	P.
11	502	" "	"	"	4.08	0.611	8.812	.065	13.75	+.21	U.
12	537	Nov. 7	12.70	9.643	6.05	0.782	8.861	.073	13.51	-.03	P.
13	571	Nov. 13	"	"	5.85	0.767	8.876	.075	13.43	-.11	P.
14	572	" "	36.60	0.102	17.33	1.239	8.863	.073	13.50	-.04	P.
15	609	Nov. 14	12.70	9.643	6.06	0.782	8.861	.073	13.51	-.03	P.
16	610	" "	"	"	5.75	0.760	8.883	.076	13.40	-.14	P.
17	611	" "	"	"	7.05	0.848	8.795	.062	13.84	+.30	U.
18	612	" "	"	"	6.83	0.834	8.809	.064	13.77	+.23	P.
19	613	" "	"	"	6.33	0.801	8.842	.070	13.60	+.06	S.
20	614	" "	"	"	5.97	0.776	8.867	.074	13.48	-.06	P.
21	654	Nov. 19	"	"	5.81	0.764	8.879	.076	13.42	-.12	P.
22	655	" "	36.60	0.102	17.03	1.231	8.871	.074	13.46	-.08	P.
23	673	Nov. 20	"	"	18.09	1.257	8.845	.070	13.59	+.05	P.
									13.54	±.13	

The constants of Photometers G and I, as stated above, are equal. Tables XXIX., XXX., and XXXI. give the first determinations of these constants by the three methods described above. The columns have the same meaning as in the preceding tables, except that no reduction of the reading to the zero of the scale is here required, and the observed readings are copied at once into the tables.

TABLE XXIX.

CONSTANT OF PHOTOMETER I BY OBSERVATION OF PLANETS THROUGH MINUTE HOLES.

No.	No. in Table I.	Date. 1878.	Hole.		Planet.		Apert.	Log $\frac{Af}{F}$	Reading.	Log Reading.	Log E.	E.	Const.	Resid.	Obs.
			Design.	Diam.	Init.	Diam.									
1	1479	Jan. 25	R 3	0.363	M.	7.1	12.70	9.813	2.168	0.336	9.477	.300	10.51	-.09	P.
2	1480	" "	"	"	M.	"	"	"	2.520	0.401	9.412	.258	10.83	+.23	S.
3	1481	" "	"	"	M.	"	"	"	2.113	0.325	9.488	.308	10.46	-.14	P.
													10.60	±.15	

TABLE XXX.

CONSTANT OF PHOTOMETERS G AND I BY OBSERVATION OF ARTIFICIAL STARS.

No.	No. in Table I.	Date. 1877-78.	Apert.	Log A.	Reading.	Log Reading.	Log E.	E.	Constant.	Resid.	Obs.
1	763	Dec. 4	.817	9.912	3.266	.514	9.398	.250	10.90	-.37	P.
2	764	" "	"	"	3.998	.602	9.310	.204	11.34	+.07	S.
3	765	" "	.725	9.860	3.894	.590	9.270	.186	11.54	+.27	S.
4	766	" "	"	"	3.736	.572	9.288	.194	11.45	+.18	S.
5	767	Dec. 5	"	"	3.548	.550	9.310	.204	11.34	+.07	P.
6	768	" "	"	"	3.612	.558	9.302	.200	11.38	+.11	P.
7	769	" "	"	"	3.244	.511	9.349	.223	11.15	-.12	S.
8	770	" "	"	"	3.484	.542	9.318	.208	11.30	+.03	S.
9	771	" "	"	"	3.256	.513	9.347	.222	11.16	-.11	S.
10	772	" "	"	"	3.566	.552	9.308	.203	11.35	+.08	S.
11	773	" "	"	"	3.226	.509	9.351	.224	11.14	-.13	S.
12	774	" "	"	"	3.518	.546	9.314	.206	11.32	+.05	S.
13	775	" "	"	"	3.294	.518	9.342	.220	11.18	-.09	S.
14	776	" "	"	"	3.376	.528	9.332	.215	11.23	-.04	S.
15	777	" "	"	"	3.378	.529	9.331	.214	11.24	-.03	U.
16	778	" "	"	"	3.608	.557	9.303	.201	11.38	+.11	U.
17	779	" "	"	"	3.804	.580	9.280	.190	11.49	+.22	P.
18	780	" "	"	"	3.702	.568	9.292	.196	11.43	+.16	P.
19	781	" "	"	"	3.400	.532	9.328	.213	11.25	-.02	P.
20	782	" "	"	"	3.420	.534	9.326	.212	11.26	-.01	P.
21	783	" "	"	"	3.424	.534	9.326	.212	11.26	-.01	P.
22	784	" "	"	"	3.526	.547	9.313	.206	11.33	+.06	P.
23	785	" "	"	"	3.480	.542	9.318	.208	11.30	+.03	S.
24	786	" "	"	"	3.730	.572	9.288	.194	11.45	+.18	S.
25	787	" "	"	"	3.674	.565	9.295	.197	11.42	+.15	P.
26	788	" "	"	"	3.648	.562	9.298	.199	11.40	+.13	P.
27	1284	Jan. 12	"	"	3.674	.565	9.295	.197	11.42	+.15	S.
28	1285	" "	"	"	3.708	.569	9.291	.195	11.44	+.17	S.
29	1286	" "	"	"	2.764	.441	9.419	.262	10.80	-.47	P.
30	1287	" "	"	"	2.740	.438	9.422	.264	10.78	-.49	P.
31	1288	" "	"	"	3.080	.489	9.371	.235	11.04	-.23	S.
32	1289	" "	"	"	3.082	.489	9.371	.235	11.04	-.23	S.
33	1290	" "	"	"	3.348	.525	9.335	.216	11.22	-.05	P.
34	1291	" "	"	"	2.994	.476	9.384	.242	10.97	-.30	P.
35	1329	Jan. 13	"	"	2.854	.455	9.405	.254	10.87	-.40	P.
36	1330	" "	"	"	2.662	.425	9.435	.272	10.72	-.55	P.
37	1331	" "	"	"	3.126	.495	9.365	.232	11.07	-.20	S.
38	1332	" "	"	"	3.052	.485	9.375	.237	11.02	-.25	S.
39	1333	Jan. 14	"	"	3.776	.577	9.283	.192	11.48	+.21	P.
40	1334	" "	"	"	3.458	.539	9.321	.209	11.29	+.02	P.
41	1335	" "	"	"	3.478	.541	9.319	.208	11.30	+.03	S.
42	1336	" "	"	"	3.442	.537	9.323	.210	11.28	+.01	S.
43	1342	" "	"	"	3.592	.555	9.305	.202	11.37	+.10	P.
44	1343	" "	"	"	3.964	.598	9.262	.183	11.58	+.31	P.
45	1344	" "	"	"	3.710	.569	9.291	.195	11.44	+.17	P.
46	1345	" "	"	"	3.448	.538	9.322	.210	11.28	+.01	P.
47	1346	" "	"	"	4.224	.626	9.234	.171	11.72	+.45	S.
48	1347	" "	"	"	4.196	.623	9.237	.173	11.71	+.44	S.
									11.27	±.17	

In these observations, the light employed was that of a lantern shining on a quartz sphere, as in the last observations with Photometer E. The flame was so much reduced that one image only appeared in each telescope.

TABLE XXXI.

CONSTANT OF PHOTOMETERS G AND I BY OBSERVATION OF SKY.

No.	No. in Table I.	Date. 1877-78.	Apert.	Log $\frac{Af}{F}$.	Reading.	Log Reading.	Log E .	E .	Constant.	Resid.	Obs.
1	699	Nov. 30	12.70	9.643	2.143	0.331	9.312	.205	11.34	+.22	P.
2	700	" "	"	"	2.176	0.338	9.305	.202	11.37	+.25	P.
3	712	Dec. 1	"	"	1.747	0.242	9.401	.252	10.89	-.23	P.
4	742	Dec. 3	"	"	1.905	0.280	9.363	.231	11.08	-.04	P.
5	743	" "	"	"	2.138	0.330	9.313	.206	11.33	+.21	S.
6	1292	Jan. 12	"	"	1.978	0.296	9.347	.222	11.16	+.04	P.
7	1293	" "	"	"	1.928	0.285	9.358	.228	11.10	-.02	P.
8	1294	" "	37.95	0.118	5.206	0.716	9.402	.252	10.88	-.24	P.
9	1398	Jan. 19	12.70	9.643	1.970	0.294	9.349	.223	11.15	+.03	P.
10	1399	" "	"	"	1.908	0.281	9.362	.230	11.08	-.04	P.
11	1400	" "	"	"	1.996	0.300	9.343	.220	11.18	+.06	S.
12	1401	" "	"	"	1.868	0.271	9.372	.235	11.03	-.09	S.
13	1672	Feb. 7	"	"	1.880	0.274	9.369	.234	11.05	-.07	P.
14	1673	" "	"	"	1.918	0.283	9.360	.229	11.09	-.03	P.
									11.12	$\pm .11$	

In the spring of 1878, it was decided to redetermine the constant of Photometer I by all three of the experimental methods given above. It is important to show that there is no sensible difference in the measurements by different observers; in other words, that the constant is the same for all. A complete series of measurements was made by each, and the results are brought together in the following tables, which are accordingly divided into three parts.

As an error once committed in estimating the equality in brightness of two objects may be repeated in consecutive settings, each observer commonly made but one set in an evening. The errors due to variations in the seeing are thus also reduced, since measurements are obtained on a larger number of nights.

The observations with minute holes are given in Table XXXII. The hole R 3 was used throughout, and the planet Jupiter was selected as the object to be observed, on account of the size of its disk and the accuracy with which its diameter is known. Each observer took a set of five readings on each of ten nights to eliminate personal equation as far as possible.

The observations by the second method are given in Table XXXIII. The object observed was at first a distant gas-light, and afterwards a real star. An aperture having a diameter of .789 cms. was used, but on July 4 it was found that it had been

changed for another having a diameter of .734 cms. This aperture was probably also used on July 3. As the difference between the two only affects the constant by about one-twelfth of a magnitude, the effect on the final result will be quite inappreciable. As in the first method, each observer took a set of five readings on ten evenings. My own set on July 1 appeared much too small. On looking again into the instrument, I found that, owing to the constrained position in which the observation was made, a portion of the light did not enter the pupil. This set was accordingly repeated, and the reading of set 8 substituted for 7 in finding the mean. If set 7 is not rejected, the mean becomes 11.01 and the average deviation .14.

TABLE XXXII.

CONSTANT OF PHOTOMETER I BY OBSERVATION OF PLANETS THROUGH MINUTE HOLES.

No.	No. in Table I.	Date. 1878.	Hole.		Planet.		Apert.	Log $\frac{AH}{P}$.	Reading.	Log Reading.	Log E.	E.	Const.	Resid.	Obs.
			Design.	Diam.	Init.	Diam.									
1	3742	Sept. 6	R 3	.363	J.	43.9	37.95	9.496	1.084	0.035	9.461	.289	10.59	-.44	P.
2	3787	Sept. 9	"	"	J.	43.6	"	9.499	1.202	0.080	9.419	.262	10.80	-.23	P.
3	4156	Oct. 3	"	"	J.	40.7	"	9.529	1.720	0.235	9.294	.197	11.42	+.39	P.
4	4167	Oct. 4	"	"	J.	40.6	"	9.530	1.836	0.264	9.266	.184	11.56	+.53	P.
5	4219	Oct. 10	"	"	J.	39.8	"	9.539	1.314	0.119	9.420	.263	10.79	-.24	P.
6	4243	Oct. 13	"	"	J.	39.5	"	9.542	1.816	0.259	9.283	.192	11.48	+.45	P.
7	4258	Oct. 14	"	"	J.	39.4	"	9.543	1.526	0.184	9.359	.229	11.10	+.07	P.
8	4281	Oct. 15	"	"	J.	39.4	"	9.544	1.264	0.102	9.442	.277	10.68	-.35	P.
9	4299	Oct. 16	"	"	J.	39.2	"	9.546	1.310	0.117	9.429	.269	10.75	-.28	P.
10	4316	Oct. 17	"	"	J.	39.0	"	9.548	1.600	0.204	9.344	.221	11.17	+.14	P.
													11.03	±.31	
1	3744	Sept. 6	R 3	.363	J.	43.9	37.95	9.496	1.412	0.150	9.346	.222	11.16	-.17	S.
2	3788	Sept. 9	"	"	J.	43.6	"	9.499	1.480	0.170	9.329	.213	11.25	-.08	S.
3	4157	Oct. 3	"	"	J.	40.7	"	9.529	1.966	0.294	9.235	.172	11.72	+.39	S.
4	4166	Oct. 4	"	"	J.	40.6	"	9.530	1.994	0.300	9.230	.170	11.74	+.41	S.
5	4217	Oct. 10	"	"	J.	39.8	"	9.539	1.580	0.199	9.340	.219	11.19	-.14	S.
6	4244	Oct. 13	"	"	J.	39.5	"	9.542	1.510	0.179	9.363	.231	11.08	-.25	S.
7	4275	Oct. 15	"	"	J.	39.4	"	9.544	1.438	0.158	9.386	.243	10.96	-.37	S.
8	4298	Oct. 16	"	"	J.	39.2	"	9.546	1.760	0.246	9.300	.200	11.39	+.06	S.
9	4318	Oct. 17	"	"	J.	39.0	"	9.548	1.876	0.273	9.275	.188	11.52	+.19	S.
10	4354	Oct. 20	"	"	J.	38.6	"	9.552	1.688	0.227	9.325	.211	11.27	-.06	S.
													11.33	±.21	
1	3743	Sept. 6	R 3	.363	J.	43.9	37.95	9.496	.886	9.947	9.549	.354	10.15	-.76	U.
2	3789	Sept. 9	"	"	J.	43.6	"	9.499	1.420	0.152	9.347	.222	11.16	+.25	U.
3	4218	Oct. 10	"	"	J.	39.8	"	9.539	1.454	0.163	9.376	.238	11.01	+.10	U.
4	4257	Oct. 14	"	"	J.	39.4	"	9.543	1.300	0.114	9.429	.268	10.75	-.16	U.
5	4280	Oct. 15	"	"	J.	39.4	"	9.544	1.332	0.124	9.420	.263	10.80	-.11	U.
6	4300	Oct. 16	"	"	J.	39.2	"	9.546	1.318	0.120	9.426	.267	10.76	-.15	U.
7	4317	Oct. 17	"	"	J.	39.0	"	9.548	1.578	0.198	9.350	.224	11.14	+.23	U.
8	4350	Oct. 18	"	"	J.	38.8	"	9.550	1.730	0.238	9.312	.205	11.34	+.43	U.
9	4372	Oct. 21	"	"	J.	38.5	"	9.554	1.498	0.176	9.378	.239	11.00	+.09	U.
10	4399	Oct. 22	"	"	J.	38.4	"	9.555	1.508	0.178	9.377	.238	11.01	+.10	U.
													10.91	±.24	

TABLE XXXIII.

CONSTANT OF PHOTOMETER I BY OBSERVATION OF ARTIFICIAL STARS.

No.	No. in Table I.	Date. 1878.	Apert.	Log <i>A</i> .	Reading.	Log Reading.	Log <i>E</i> .	<i>E</i> .	Constant.	Resid.	Obs.
1	2704	May 22	.789	9.897	3.768	0.576	9.321	.209	11.29	+.21	P.
2	2769	June 3	"	"	3.632	0.560	9.337	.217	11.21	+.13	P.
3	2794	June 5	"	"	3.156	0.499	9.398	.250	10.90	-.18	P.
4	2855	June 13	"	"	3.340	0.524	9.373	.236	11.03	-.05	P.
5	2953	June 20	"	"	3.326	0.522	9.375	.237	11.02	-.06	P.
6	3050	June 29	"	"	3.564	0.552	9.345	.221	11.17	+.09	P.
7	3114	July 1	"	"	2.472	0.393	9.504	.319	[10.37]		P.
8	3117	" "	"	"	3.354	0.526	9.371	.235	11.04	-.04	P.
9	3130	July 3	.734	9.866	3.058	0.485	9.381	.240	10.99	-.09	P.
10	3159	July 4	"	"	3.160	0.500	9.366	.232	11.06	-.02	P.
11	3174	July 5	.789	9.897	3.374	0.528	9.369	.234	11.05	-.03	P.
									11.08	±.09	
12	2706	May 22	.789	9.897	4.204	0.624	9.273	.187	11.53	+.58	S.
13	2745	May 27	"	"	2.886	0.460	9.437	.273	10.71	-.24	S.
14	2792	June 5	"	"	3.376	0.528	9.369	.234	11.05	+.10	S.
15	2857	June 13	"	"	3.326	0.522	9.375	.237	11.02	+.07	S.
16	2952	June 20	"	"	3.642	0.561	9.336	.217	11.21	+.26	S.
17	3051	June 29	"	"	2.964	0.472	9.425	.266	10.77	-.18	S.
18	3116	July 1	"	"	3.006	0.478	9.419	.262	10.80	-.15	S.
19	3118	July 2	"	"	3.210	0.506	9.391	.246	10.94	-.01	S.
20	3140	July 3	.734	9.866	2.434	0.386	9.480	.302	10.49	-.46	S.
21	3161	July 4	"	"	3.032	0.482	9.384	.242	10.97	+.02	S.
									10.95	±.21	
22	2705	May 22	.789	9.897	3.590	0.555	9.342	.220	11.18	+.03	U.
23	2774	June 3	"	"	3.460	0.539	9.358	.228	11.10	-.05	U.
24	2796	June 5	"	"	4.552	0.658	9.239	.173	11.70	+.55	U.
25	2856	June 13	"	"	3.746	0.574	9.323	.210	11.28	+.13	U.
26	2960	June 20	"	"	3.390	0.530	9.367	.233	11.06	-.09	U.
27	3115	July 1	"	"	3.386	0.530	9.367	.233	11.06	-.09	U.
28	3119	July 2	"	"	3.308	0.519	9.378	.239	11.00	-.15	U.
29	3131	July 3	.734	9.866	3.044	0.483	9.383	.242	10.98	-.17	U.
30	3160	July 4	"	"	3.176	0.502	9.364	.231	11.07	-.08	U.
31	3175	July 5	.789	9.897	3.352	0.525	9.372	.235	11.03	-.12	U.
									11.15	±.15	

In the third method of determining the constant, the aperture of the large telescope was altered after each setting. The readings thus became more independent, as the recollection of the observer could not prejudice his settings, and his personal equation was thus less likely to affect them all alike. The aperture was first reduced to 25.51 cms. by a cap. A further reduction was made by a series of plates, originally constructed for the purpose of diminishing the aperture of the Meridian Circle of the Observatory, so that the light of a star observed with this instrument might be reduced by any desired number of tenths of a magnitude. The aperture of the telescope of

the Meridian Circle is 20.95 cms., the logarithm of which is 1.321. To reduce the light one-tenth of a magnitude, the logarithm of the area must be reduced .04; since the area is proportional to the square of the diameter, the logarithm of the diameter must be reduced .02, or made equal to 1.301. The diameters required to reduce the apertures by tenths of a magnitude from 0.1 to 3.0 and also to produce a reduction of 3.5, 4.0, 4.5, and 5.0, were then computed. Plates were attached to the face-plate of a lathe, and holes cut in them of this size. The plates were then marked with the numbers denoting the reduction in magnitudes. To check the work, two diameters of each plate at right angles to each other were then measured. In three cases only was the difference in the two diameters more than .02 cms. In plates .5 and 2.6, the difference equalled .03 cms., and in plate 2.5 it was .06, probably owing to a real ellipticity of the hole. In the other cases, the mean difference of the diameters equalled .01 cms., probably mainly due to errors of measurement or irregularity of the holes. The mean diameters are given in Table XXXIV. The first column gives the designation of the plate, *C* denoting that the cap alone was used. The second column gives the measured diameter of the aperture, and the third column its logarithm. The fourth column gives the error, which should be multiplied by five to reduce it to magnitudes. From this it appears that the greatest error is only .03 of a magnitude, while the average deviation is less than .01. These errors are quite inappreciable, and may be neglected.

To determine the constant by this method, the eye-piece was focused on the edge of the prism, both telescopes directed towards the same portion of the sky, and carefully focused for parallel rays. After the first two series, a diaphragm was inserted in the eye-piece, limiting the field of view to a small circle.

The plates were then held in turn in front of the objective, and for each plate one observation was made of the reading at which the two halves of the field appeared equally bright. The observer was wholly unprejudiced, since he could not see the screw-head when making the setting, and was not informed which plate was held in front of the large telescope. Five readings were also taken with the cap alone. One was made before and one after the plates were used, and the other three near the beginning, middle, and end of the series. The order of the plates was determined by chance, that it might bear no relation to the size of the apertures.

Each observer made a complete series of thirty-nine readings on each of five days. When the light was strong the difference in color of the objectives of the large and small telescopes gave different tints to the two halves of the field. Most of the series were made during twilight, when this effect was less marked. The prism generally covered the left half of the field, but it was sometimes placed to the right.

TABLE XXXIV.

CONSTANT OF PHOTOMETER I BY OBSERVATION OF SKY.

Plate.	Aperture.	Log A .	Error.	Log $\frac{Af}{F}$.	Reading.	Log Reading.	Log E .	E .	Constant.	Resid.	Obs.
C	25.51	1.407		9.946	3.580	0.554	9.392	.247	10.93	-.02	P.
C	"	"		"	3.538	0.549	9.397	.249	10.91	-.04	P.
C	"	"		"	3.706	0.569	9.377	.238	11.01	+.06	P.
C	"	"		"	3.628	0.560	9.386	.243	10.96	+.01	P.
C	"	"		"	3.770	0.576	9.370	.234	11.04	+.09	P.
.1	20.00	1.301	-.001	9.840	2.734	0.437	9.403	.253	10.88	-.07	P.
.2	19.07	1.280	-.002	9.819	2.640	0.422	9.397	.249	10.91	-.04	P.
.3	18.26	1.262	.000	9.801	2.578	0.411	9.390	.245	10.94	-.01	P.
.4	17.47	1.242	.000	9.781	2.426	0.385	9.396	.249	10.91	-.04	P.
.5	16.76	1.224	+.002	9.763	2.360	0.373	9.390	.245	10.94	-.01	P.
.6	15.99	1.204	+.002	9.743	2.268	0.356	9.387	.244	10.96	+.01	P.
.7	15.23	1.183	+.001	9.722	2.108	0.324	9.398	.250	10.90	-.05	P.
.8	14.48	1.161	-.001	9.700	2.070	0.316	9.384	.242	10.97	+.02	P.
.9	13.93	1.144	+.002	9.683	1.962	0.293	9.390	.245	10.94	-.01	P.
1.0	13.26	1.123	+.001	9.662	1.826	0.262	9.400	.251	10.89	-.06	P.
1.1	12.61	1.101	-.001	9.640	1.788	0.252	9.388	.244	10.95	.00	P.
1.2	12.15	1.085	+.003	9.624	1.682	0.226	9.398	.250	10.90	-.05	P.
1.3	11.48	1.060	-.002	9.599	1.644	0.216	9.383	.242	10.98	+.03	P.
1.4	10.99	1.041	-.001	9.580	1.552	0.191	9.389	.245	10.95	.00	P.
1.5	10.49	1.021	-.001	9.560	1.468	0.167	9.393	.247	10.93	-.02	P.
1.6	10.05	1.002	.000	9.541	1.418	0.152	9.389	.245	10.95	.00	P.
1.7	9.62	0.983	+.001	9.522	1.342	0.128	9.394	.248	10.92	-.03	P.
1.8	9.16	0.962	.000	9.501	1.298	0.113	9.388	.244	10.95	.00	P.
1.9	8.70	0.940	-.002	9.479	1.228	0.089	9.390	.245	10.94	-.01	P.
2.0	8.38	0.923	+.001	9.462	1.182	0.073	9.389	.245	10.95	.00	P.
2.1	7.90	0.898	-.004	9.437	1.116	0.048	9.389	.245	10.95	.00	P.
2.2	7.63	0.883	+.001	9.422	1.092	0.038	9.384	.242	10.97	+.02	P.
2.3	7.31	0.864	+.002	9.403	.986	9.994	9.409	.256	10.85	-.10	P.
2.4	6.92	0.840	-.002	9.379	.970	9.987	9.392	.247	10.93	-.02	P.
2.5	6.59	0.819	-.003	9.358	.906	9.957	9.401	.252	10.89	-.06	P.
2.6	6.33	0.801	-.001	9.340	.882	9.945	9.395	.248	10.92	-.03	P.
2.7	6.08	0.784	+.002	9.323	.882	9.945	9.378	.239	11.00	+.05	P.
2.8	5.67	0.754	+.002	9.293	.816	9.912	9.381	.240	10.99	+.04	P.
2.9	5.53	0.743	+.001	9.282	.814	9.911	9.371	.235	11.04	+.09	P.
3.0	5.29	0.723	+.001	9.262	.766	9.884	9.378	.239	11.00	+.05	P.
3.5	4.13	0.616	-.006	9.155	.606	9.782	9.373	.236	11.03	+.08	P.
4.0	3.31	0.520	-.002	9.059	.468	9.670	9.389	.245	10.95	.00	P.
4.5	2.62	0.418	-.004	8.957	.380	9.580	9.377	.238	11.01	+.06	P.
5.0	2.14	0.330	-.002	8.869	.300	9.477	9.392	.247	10.93	-.02	P.
									10.95	$\pm .033$	

The remainder of the table is divided into three parts of seven columns each. These contain the mean reading, its logarithm, the logarithm of the equivalent aperture, the equivalent aperture, the logarithm of the constant, its residual, and the initial of the observer. In one instance, a recorded reading of 1.86, which was manifestly erroneous, was corrected to .86. The first five lines give the observations with the cap alone, one line corresponding to each series.

TABLE XXXIV.

CONSTANT OF PHOTOMETER I BY OBSERVATION OF SKY.

Reading.	Log Reading.	Log E.	E.	Const.	Resid.	Obs.	Reading.	Log Reading.	Log E.	E.	Const.	Resid.	Obs.
4.182	0.621	9.325	.211	11.27	+.17	S.	3.750	0.574	9.372	.235	11.03	-.04	U.
3.854	0.586	9.360	.229	11.09	-.01	S.	3.788	0.578	9.368	.233	11.05	-.02	U.
3.798	0.580	9.366	.232	11.06	-.04	S.	4.046	0.607	9.339	.218	11.20	+.13	U.
3.858	0.586	9.360	.229	11.09	-.01	S.	4.064	0.609	9.337	.217	11.21	+.14	U.
3.844	0.585	9.361	.230	11.09	-.01	S.	4.048	0.607	9.339	.218	11.20	+.13	U.
3.036	0.482	9.358	.228	11.10	.00	S.	3.002	0.477	9.363	.231	11.08	+.01	U.
2.890	0.461	9.358	.228	11.10	.00	S.	2.918	0.465	9.354	.226	11.12	+.05	U.
2.694	0.430	9.371	.235	11.04	-.06	S.	2.660	0.425	9.376	.238	11.01	-.06	U.
2.624	0.419	9.362	.230	11.08	-.02	S.	2.596	0.414	9.367	.233	11.06	-.01	U.
2.482	0.395	9.368	.233	11.05	-.05	S.	2.458	0.391	9.372	.235	11.03	-.04	U.
2.386	0.378	9.365	.232	11.07	-.03	S.	2.342	0.370	9.373	.236	11.03	-.04	U.
2.394	0.379	9.343	.220	11.18	+.08	S.	2.280	0.358	9.364	.231	11.07	.00	U.
2.202	0.343	9.357	.228	11.11	+.01	S.	2.142	0.331	9.369	.234	11.05	-.02	U.
2.178	0.338	9.345	.221	11.17	+.07	S.	2.080	0.318	9.365	.232	11.07	.00	U.
2.002	0.301	9.361	.230	11.09	-.01	S.	1.984	0.298	9.364	.231	11.07	.00	U.
1.982	0.297	9.343	.220	11.18	+.08	S.	1.890	0.276	9.364	.231	11.07	.00	U.
1.936	0.287	9.337	.217	11.21	+.11	S.	1.780	0.250	9.374	.237	11.02	-.05	U.
1.710	0.233	9.366	.232	11.06	-.04	S.	1.704	0.231	9.368	.233	11.05	-.02	U.
1.600	0.204	9.376	.238	11.01	-.09	S.	1.588	0.201	9.379	.239	11.00	-.07	U.
1.564	0.194	9.366	.232	11.06	-.04	S.	1.592	0.202	9.358	.228	11.10	+.03	U.
1.500	0.176	9.365	.232	11.07	-.03	S.	1.456	0.163	9.378	.239	11.00	-.07	U.
1.498	0.176	9.346	.222	11.16	+.06	S.	1.448	0.161	9.361	.230	11.09	+.02	U.
1.398	0.146	9.355	.226	11.12	+.02	S.	1.298	0.113	9.388	.244	10.95	-.12	U.
1.334	0.125	9.354	.226	11.12	+.02	S.	1.322	0.121	9.358	.228	11.10	+.03	U.
1.224	0.088	9.374	.237	11.02	-.08	S.	1.302	0.115	9.347	.222	11.16	+.09	U.
1.230	0.090	9.347	.222	11.16	+.06	S.	1.224	0.088	9.349	.223	11.15	+.08	U.
1.190	0.075	9.347	.222	11.16	+.06	S.	1.138	0.056	9.366	.232	11.06	-.01	U.
1.118	0.048	9.355	.226	11.12	+.02	S.	1.042	0.018	9.385	.243	10.97	-.10	U.
1.026	0.011	9.368	.233	11.05	-.05	S.	1.020	0.009	9.370	.234	11.04	-.03	U.
1.010	0.004	9.354	.226	11.12	+.02	S.	.968	9.986	9.372	.235	11.03	-.04	U.
.934	9.970	9.370	.234	11.04	-.06	S.	.934	9.970	9.370	.234	11.04	-.03	U.
.916	9.962	9.361	.230	11.09	-.01	S.	.936	9.971	9.352	.225	11.13	+.06	U.
.882	9.945	9.348	.223	11.15	+.05	S.	.848	9.928	9.365	.232	11.07	.00	U.
.822	9.915	9.367	.233	11.06	-.04	S.	.836	9.922	9.360	.229	11.09	+.02	U.
.798	9.902	9.360	.229	11.09	-.01	S.	.808	9.907	9.355	.226	11.12	+.05	U.
.650	9.813	9.342	.220	11.18	+.08	S.	.638	9.805	9.350	.224	11.14	+.07	U.
.484	9.685	9.374	.237	11.02	-.08	S.	.482	9.683	9.376	.238	11.01	-.06	U.
.400	9.602	9.355	.226	11.12	+.02	S.	.398	9.600	9.357	.228	11.11	+.04	U.
.318	9.502	9.367	.233	11.06	-.04	S.	.328	9.516	9.353	.225	11.13	+.06	U.
				11.10	±.045						11.07	±.047	

The constant of Photometer E' was determined experimentally by the method of artificial stars. The results are shown in Table XXXV.

TABLE XXXV.

CONSTANT OF PHOTOMETER E' BY OBSERVATION OF ARTIFICIAL STARS.

No.	No. in Table I.	Date. 1877.	Apert.	Log <i>A</i> .	Reading.	Log Reading.	Log <i>E</i> .	<i>E</i> .	Constant.	Resid.	Obs.
1	374	Oct. 10	.247	9.393	14.83	1.171	8.222	.017	16.70	+.64	S.
2	375	" "	"	"	15.18	1.181	8.212	.016	16.75	+.69	S.
3	376	" "	"	"	13.01	1.114	8.279	.019	16.42	+.36	P.
4	377	" "	"	"	12.58	1.100	8.293	.020	16.35	+.29	P.
5	378	" "	.135	9.130	4.96	0.695	8.435	.027	15.64	-.42	P.
6	379	" "	"	"	4.91	0.691	8.439	.027	15.62	-.44	P.
7	380	" "	"	"	5.00	0.699	8.431	.027	15.66	-.40	S.
8	381	" "	"	"	5.23	0.718	8.412	.026	15.75	-.31	S.
9	382	" "	"	"	5.46	0.737	8.393	.025	15.85	-.21	U.
10	383	" "	"	"	5.52	0.742	8.388	.024	15.87	-.19	U.
									16.06	±.39	

The first four sets give a mean value of the constant of 16.56 with an average deviation of .17. This agrees well with the theoretical value. A smaller diaphragm was then used which enlarged the images by diffraction. Six sets gave the much smaller value of the constant 15.73 with an average deviation of .09. Probably these readings are in error, but as this view is supported only by their discordance from the theoretical value, their rejection does not seem to be justified. They are accordingly retained in the mean.

The only experimental determination of the constant of Photometer J has been by the method of comparison. Each of the observers measured the light of Iapetus, the outer satellite of Saturn, on ten evenings, by Photometer I and also by J. A similar comparison was also made with a star of about the thirteenth magnitude which is denoted in Chapter IX. as star *b*. The results are given in Table XXXVI. The first column gives the current number, the second the date, the third the number in Table I. of the observation of Iapetus with Photometer I, the fourth the corresponding number for Photometer J. The fifth and sixth columns give the differences in magnitude corresponding to the readings in these sets. The seventh equals the sixth *minus* the fifth column, subtracting ten when the characteristic of the logarithm of the reading is negative. The eighth column gives the differences of these columns from the mean. The next six columns give the corresponding numbers for star *b*. The last column gives the initial of the observer.

TABLE XXXVI.

CONSTANT OF PHOTOMETER J BY COMPARISON WITH I.

No.	Date. 1878-79.	Observations of Iapetus.						Observations of Star <i>b</i> .						Obs.		
		No. in Table I.		Diff. in Magnitude.			Resid.	No. in Table I.		Diff. in Magnitude.			Resid.			
		I.	J.	I.	J.	J—I.		I.	J.	I.	J.	J—I.				
1	Dec. 14	4674	4678	9.70	2.23	2.53	— .52	4673	4677	9.91	3.07	3.16	— .05	P.		
2	Dec. 16	4686	4681	9.49	2.61	3.12	+ .07	4685	4682	9.32	2.47	3.15	— .06	P.		
3	Dec. 17	4700	4704	9.75	2.95	3.20	+ .15	4701	4705	9.37	3.18	3.81	+ .60	P.		
4	Dec. 18	4710	4708	8.93	2.16	3.23	+ .18	4711	4709	8.96	2.32	3.36	+ .15	P.		
5	Dec. 19	4727	4725	9.22	2.41	3.19	+ .14	4726	4724	9.13	2.21	3.08	— .13	P.		
6	Dec. 20	4730	4729	9.43	2.47	3.04	— .01	4731	4728	9.52	2.22	2.70	— .51	P.		
7	Dec. 23	4734	4741	9.43	2.78	3.35	+ .30	4735	4740	9.19	2.25	3.06	— .15	P.		
8	Dec. 24	4745	4747	0.32	2.82	2.50	— .55	4744	4746	9.54	2.28	2.74	— .47	P.		
9	Dec. 25	4752	4751	9.57	3.41	3.84	+ .79	4753	4750	9.24	3.03	3.79	+ .58	P.		
10	Dec. 26	4767	4758	0.49	3.03	2.54	— .51	4764	4759	9.39	2.63	3.24	+ .03	P.		
						3.05	± .32							3.21	± .27	
1	Dec. 13	4669	4665	9.46	1.94	2.48	— .09	4670	4666	0.14	1.86	1.72	— 1.00	S.		
2	Dec. 14	4675	4679	9.32	2.18	2.86	+ .29	4676	4680	9.67	2.66	2.99	+ .27	S.		
3	Dec. 16	4687	4684	9.40	2.55	3.15	+ .58	4688	4683	0.06	3.32	3.26	+ .54	S.		
4	Jan. 3	4782	4786	0.75	3.12	2.37	— .20	4783	4787	9.43	2.68	3.25	+ .53	S.		
5	Jan. 5	4788	4791	0.48	2.71	2.23	— .34	4790	4792	9.54	2.47	2.93	+ .21	S.		
6	Jan. 6	4796	4794	0.36	2.69	2.33	— .24	4797	4795	9.10	2.18	3.08	+ .36	S.		
7	Jan. 7	4802	4806	1.11	3.77	2.66	+ .09	4803	4807	0.32	2.24	1.92	— .80	S.		
8	Jan. 12	4817	4818	0.06	2.74	2.68	+ .11	4816	4819	9.06	2.22	3.16	+ .44	S.		
9	Jan. 18	4828	4826	0.52	2.75	2.23	— .34	4829	4827	0.45	2.34	1.89	— .83	S.		
10	Jan. 19	4833	4836	9.77	2.52	2.75	+ .18	4834	4837	8.80	1.78	2.98	+ .26	S.		
						2.57	± .25							2.72	± .52	
1	Dec. 13	4672	4668	9.29	2.37	3.08	+ .39	4671	4667	9.67	2.46	2.79	— .08	U.		
2	Dec. 16	4689	4691	9.65	1.86	2.21	— .48	4690	4692	0.00	2.41	2.41	— .46	U.		
3	Dec. 17	4702	4706	9.49	2.55	3.06	+ .37	4703	4707	9.35	2.63	3.28	+ .41	U.		
4	Dec. 18	4718	4716	9.82	1.72	1.90	— .79	4719	4717	9.96	2.95	2.99	+ .12	U.		
5	Dec. 19	4720	4722	9.93	2.21	2.28	— .41	4721	4723	9.75	2.48	2.73	— .14	U.		
6	Dec. 23	4737	4738	9.40	2.67	3.27	+ .58	4736	4739	9.72	2.68	2.96	+ .09	U.		
7	Dec. 24	4742	4748	9.86	2.59	2.73	+ .04	4743	4749	9.81	2.86	3.05	+ .18	U.		
8	Dec. 25	4755	4756	9.87	2.88	3.01	+ .32	4754	4757	9.85	2.64	2.79	— .08	U.		
9	Dec. 26	4762	4761	0.50	3.02	2.52	— .17	4763	4760	9.96	2.51	2.55	— .32	U.		
10	Dec. 30	4772	4776	0.13	3.00	2.87	+ .18	4773	4777	9.18	2.37	3.19	+ .32	U.		
						2.69	± .37							2.87	± .22	

The results of the above measurements are given in Table XXXVII. The columns give the current number, the method, the observer, the number of separate values used in deducing the mean value of the constant given in the next column, the average deviation of that value from the mean, and the residual from the theoretical value, which is that adopted.

PHOTOMETRIC OBSERVATIONS.

TABLE XXXVII.

COMPARISONS OF DETERMINATIONS OF CONSTANTS.

No.	Method.	Obs.	No. Sets.	Constant.	Av. Dev.	Resid.
PHOTOMETER E.						
1	Theoretical	—	—	13.50	—	.00
2	Minute Holes	—	10	12.95	.17	-.55
3	Artificial Stars	—	30	13.74	.18	+.24
4	Sky	—	23	13.54	.13	+.04
5	All	—	63	13.41	.31	-.09
6	Mean by Weights	—	63	13.54	—	+.04
7	Adopted	—	—	13.50	—	—
PHOTOMETERS G AND I.						
1	Theoretical	—	—	11.10	—	.00
2	Minute Holes	—	3	10.60	.15	-.50
3	Artificial Stars	—	48	11.27	.17	+.17
4	Sky	—	14	11.12	.11	+.02
5	All	—	65	11.00	.26	-.10
6	Mean by Weights	—	65	11.21	—	+.11
7	Adopted	—	—	11.10	—	—
PHOTOMETER I. (Second Series.)						
1	Theoretical	—	—	11.10	—	.00
2	Minute Holes	P.	10	11.03	.31	-.07
3	" "	S.	10	11.33	.21	+.23
4	" "	U.	10	10.91	.24	-.19
5	Artificial Stars	P.	10	11.08	.09	-.02
6	" "	S.	10	10.95	.21	-.15
7	" "	U.	10	11.15	.15	+.05
8	Sky	P.	39	10.95	.03	-.15
9	"	S.	39	11.10	.04	.00
10	"	U.	39	11.07	.05	-.03
11	Minute Holes	All.	30	11.09	.16	-.01
12	Artificial Stars	All.	30	11.06	.07	-.04
13	Sky	All.	117	11.04	.06	-.06
14	All Methods	P.	59	11.02	.05	-.08
15	" "	S.	59	11.13	.14	+.03
16	" "	U.	59	11.04	.09	-.06
17	" "	All.	177	11.06	.09	-.04
18	Adopted	—	—	11.10	—	—
PHOTOMETER E'.						
1	Theoretical	—	—	16.40	—	.00
2	Observations	—	10	16.06	.39	-.34
3	Adopted	—	—	16.40	—	—

No.	Method.	Obs.	No. Sets.	Constant.	Av. Dev.	Resid.
PHOTOMETER J.						
1	Theoretical		—	14.00	—	.00
2	Iapetus	P.	10	14.15	.32	+.15
3	"	S.	10	13.67	.25	-.33
4	"	U.	10	13.79	.37	-.21
5	Star <i>b</i>	P.	10	14.31	.27	+.31
6	"	S.	10	13.82	.52	-.18
7	"	U.	10	13.97	.22	-.03
8	Both	P.	20	14.23	.08	+.23
9	"	S.	20	13.74	.12	-.26
10	"	U.	20	13.88	.09	-.12
11	Iapetus		30	13.87	.19	-.13
12	Star <i>b</i>		30	14.03	.18	+.03
13	All		60	13.95	.19	-.05
14	Adopted		—	14.00	—	—

The progressive improvement in these measurements is well shown by comparing the results for Photometers E, G, and I. The three methods in the first case differ from that given by theory about three-tenths of a magnitude, in the second case two-tenths, and in the third case less than one-tenth. As was to be expected from the discussion on page 203, the method by minute holes generally gave too small a result. The observations by the second method are generally rather large. Those by the third method are more accordant than either of the others, and agree closely with the results of theory. This is probably the most convenient method of finding the constant experimentally.

The theoretical values for E and G fall nearly midway between the mean of the results of the three methods and the mean of all the sets. The theoretical value of I is very slightly greater than that given by observations. So few observations were made with E' that the discordance of the measurement of its constant is of little importance. The observations of the constant of J are somewhat discordant, so that it is doubtful if the differences between their mean value and that given by theory is more than accidental.

The values of the constants adopted for reducing all the observations made with these photometers are those given by theory. Accordingly, the constant of E will hereafter be taken = 13.50, that of G and I = 11.10, that of E' = 16.40, and that of J = 14.00. When the aperture is reduced, the constant is changed by an amount equal to the diminution in light of a star seen in the large telescope, since the images in the auxiliary telescope are unchanged. In some of the observations with Photometer E the aperture was reduced from 36.60 to 12.70. The corresponding change

in magnitudes equals $\frac{[\log 36.60^2 - \log 12.70^2]}{0.4} = 5 [1.563 - 1.104] = 2.30$. The constant, therefore, becomes $13.50 - 2.30 = 11.20$. As the full aperture of the telescope after November, 1877, was 37.95 cms., the constant of Photometers G and I becomes $11.10 - 5 (1.579 - 1.104) = 8.72$ when the aperture is reduced to 12.70 cms. The same value of the constant may be used with the West Equatorial, as its available aperture equals 12.70 cms.

The discussion already made of the errors of Photometer H seemed to show that the position and distance of the images have no appreciable effect on the measurements. In the latter part of January, 1879, when the work which had been laid out was nearly completed, a curious source of systematic error was noticed in the observations with Photometer I. The readings of the light of Iapetus, the outer satellite of Saturn, appeared to be greater when the prism was in the upper or right-hand portion of the field than when in the opposite position. During the next six weeks, a careful study was made of this phenomenon, without, however, eliciting a satisfactory explanation. Several sets of measures of Iapetus, and also of a faint star near it denoted as *b*, were taken first with the prism on one side of the field and then on the other. The details have been given in Table I., and a summary of the results is shown in lines 1, 2, and 3 of Table XXXVIII. The first column gives a current number, and the second the position of the prism. When the latter was to the left, the result was combined with the readings when the prism was below. The next nine columns are divided into three groups, corresponding to the three observers. The columns headed I. give the mean observed differences in magnitude of Saturn and Iapetus, columns II. give the corresponding values for star *b*, and the next columns give their mean. These quantities are derived from the reading *r* of each set by the formula given on page 206, $M = 11.10 - 5 \log r$. The last column gives the mean of the whole. Only those sets are used in which the same observer measured the object on the same evening with the prism in two positions.

Lines 1, 2, and 3 of the second part of the Table give the residuals of these various magnitudes from their mean value of 11.65. The remaining lines of both parts of the Table relate to two stars near *a Leonis*. The columns headed I. give the measurements of a star 3' preceding, denoted as *a Leonis c*; column II. gives those of a star 6' south following, which will be designated as *a Leonis d*. To render these last measurements wholly independent, the readings of the screw-head were made by the recorder, so that the observer had no means of knowing whether his results were accordant or not.

TABLE XXXVIII.

POSITION OF PRISM.

No.	Position.	P.			S.			U.			All.
		I.	II.	Mean.	I.	II.	Mean.	I.	II.	Mean.	Mean.
DIFFERENCES IN MAGNITUDE.											
1	Below	11.40	11.98	11.69	12.03	12.67	12.35	11.28	11.76	11.52	11.85
2	Above	11.12	11.41	11.26	11.52	11.61	11.56	11.11	11.92	11.52	11.45
3	Mean	11.26	11.70	11.48	11.78	12.14	11.95	11.20	11.84	11.52	11.65
4	Right	10.62	10.18	10.40	11.23	11.19	11.21	12.16	11.62	11.89	11.17
5	Below	11.62	11.67	11.64	12.37	12.20	12.28	12.31	11.73	12.02	11.98
6	Left	12.04	11.44	11.72	12.34	11.60	11.19	12.10	11.46	11.78	11.56
7	Above	11.04	11.00	11.02	11.46	10.00	10.73	12.02	11.05	11.54	11.10
8	Mean	11.33	11.07	11.20	11.85	11.25	11.35	12.15	11.46	11.81	11.45
RESIDUALS.											
1	Below	-.25	+ .33	+ .04	+.38	+1.02	+.70	-.37	+.11	-.13	+.20
2	Above	-.53	- .24	- .39	-.13	- .04	-.09	-.54	+.27	-.13	-.20
3	Mean	-.39	+ .05	- .17	+.13	+ .49	+.30	-.45	+.19	-.13	.00
4	Right	-.83	-1.27	-1.05	-.22	- .26	-.24	+.71	+.17	+.44	-.28
5	Below	+.17	+ .22	+ .19	+.92	+ .75	+.83	+.86	+.28	+.57	+.53
6	Left	-.59	- .01	+ .27	+.89	+ .15	-.26	+.65	+.01	+.33	+.11
7	Above	-.41	- .45	- .43	+.01	-1.45	-.72	+.57	-.40	+.09	-.35
8	Mean	-.12	- .38	- .25	+.40	- .20	-.10	+.70	+.01	+.36	.00

The results indicate a systematic error by which the difference in magnitudes is too small, or the object appears too bright, when the prism is to the right or above; the opposite effect is obtained when the prism is below. In the majority of cases the prism was placed to the left, since in this position the screw could be more easily set. In most of the observations of the constant, the instrument was so placed. When the object assumed as a standard was to the right of the object to be measured, the telescope or mounting would often obstruct the view in the small telescope. It was then turned to a more convenient position. The edges of the prism were commonly set at right angles to the line joining the objects compared, when these were very near each other, in order that the bright object might be concealed behind the prism.

As this source of error was not detected until most of the observations were completed, we have no means of knowing how far it affected them. There are reasons for believing that it was due to some temporary or local cause. The satellites of all the planets were observed on each side of their primaries, so that the prisms were turned part of the time to the right and part of the time to the left. No systematic differ-

ences are noticeable between them. Again, no marked systematic differences are to be found in the results of different observers, as should be the case if these errors occurred throughout the series. It will be noticed that, although the deviations have the same sign for all the observers, their magnitude is much less for Mr. Upton's observations than for Mr. Searle's or mine. On the whole, it appears safest not to apply a correction in the present case. In future observations it would be advisable for each observer to make a careful series of measurements of the same star in various positions of the prism, and to repeat these observations at intervals during the work.

When the objects to be compared are near, another remedy would be to reduce the field to a small circular hole in the centre of which the faint object should be placed. The bright object would then always be covered by the edges of the hole, and the prism could always be placed in the same position as that in which the constant was determined.

Although the observations discussed on page 169 showed that the effect of slight changes in the focus was imperceptible in the measurements, it does not follow that this will be the case with Photometer I. Observations were accordingly made on α Leonis D, in which the focus was altered one and two centimetres. The effects of variations in the seeing were thus imitated, the bright star remaining a minute point while the faint star was much enlarged. Five sets were taken by each observer on two evenings. The differences in magnitude are given in the first part of Table

TABLE XXXIX.

FOCUS.

Focus.	P.			S.			U.			All
	I.	II.	Mean.	I.	II.	Mean.	I.	II.	Mean.	Mean.
DIFFERENCES IN MAGNITUDE.										
-2	11.91	12.97	12.44	12.34	12.57	12.46	12.80	11.85	12.32	12.41
-1	11.57	12.56	12.06	11.96	12.73	12.34	12.68	11.54	12.11	12.17
0	11.37	12.45	11.91	12.12	12.50	12.31	12.22	11.52	11.87	12.03
+1	11.28	12.59	11.94	12.40	12.90	12.65	12.51	11.87	12.19	12.26
+2	11.38	13.02	12.70	12.92	14.28	13.60	13.09	12.17	12.63	12.98
RESIDUALS.										
-2	-.12	+.94	+.41	+.31	+.54	+.43	+.77	-.18	+.29	+.38
-1	-.46	+.53	+.03	-.07	+.70	+.31	+.65	-.49	+.08	+.14
0	-.66	+.42	-.12	+.09	+.47	+.28	+.19	-.51	-.16	.00
+1	-.75	+.56	-.09	+.37	+.87	+.62	+.48	-.16	+.16	+.23
+2	+.35	+.99	+.67	+.89	+.25	+1.57	+1.06	+.14	+.60	+.95

XXXIX. The first column gives the distance in centimetres from the focus; a positive sign denoting that the eye-piece is drawn out, a negative that it is pushed in. The results for each observer for each evening are given in the columns headed I. and II. These are followed by their mean, and the mean of the whole is given in the last column. The mean of all the readings when the focus was exact is 12.03. The residuals are found in the last part of the Table by subtracting this quantity from each of the differences in magnitude. All the readings were made by the recorder, who also varied the focus, so that the observer should not be influenced by his judgment.

The variations are here much greater than would occur in the ordinary use of the instrument, but they show that the residuals will be positive when the images are large. The faint star will then appear fainter than it really is.

The star α *Leonis* was observed several times with the bright star in the field, and placed at an equal distance from the two images to be compared; and again with the bright star behind the prism. The readings are generally larger when α was in the field. The difference in two such comparisons by Mr. Searle was +.31 and +.97, or a mean of +.64; two by Mr. Upton gave +.45 and +.36, giving a mean of +.40; four by myself gave -.08, +.09, +.67, and +.89 with a mean of +.43.

Since these sources of systematic error are liable to be present in measures of these objects with almost any form of photometer, they show how much care should be taken to eliminate them if the greatest accuracy is to be expected.

CHAPTER VII.

SATELLITES OF MARS.

THE discovery of the satellites of Mars suggested a photometric problem of no little difficulty. To measure their brightness in terms of that of their primary, involved the determination of a photometric interval as great as that between the Sun and Moon; while the faintness of the satellites was such as to preclude the ordinary methods of measurement. The photometers chiefly used in the observations had not at that time been invented, and the short period during which the satellites would remain visible required immediate action. A large portion of the day was consumed in planning the required instruments, superintending their construction, testing their performance, and measuring their constants, while the south declination of the planet required that the observations should extend late into the night. Moreover, as a series of micrometric observations of the satellites was in progress at the same time, the photometer had to be replaced and readjusted every afternoon, which was a matter of no little difficulty. The minuteness of the satellites often occasioned the loss of much time in searching for them, and also delayed the observations themselves, so that the time given in the records by no means represents that actually devoted to the measurements.

As the light of Mars is several hundred thousand times that of its satellites, and as it subtends a large disk in the telescope, a direct comparison is impossible. The planet, therefore, must first be reduced by a known amount, so that it shall resemble a star, and some method must then be employed for comparing this with the satellites. The diameter of the image of Mars in the telescope was nearly one millimetre. If, therefore, a plate of metal with a circular hole a hundredth of a millimetre in diameter is inserted in the focus of the telescope, only a small part of the disk of Mars will shine through it, forming a star which may be compared photometrically with the satellite. If, moreover, we know the angular diameter of Mars, the focal length of the telescope, and the diameter of the hole, the exact amount of the reduction may be computed. The difficulty of making such a hole is, however, very great, as is shown by the various attempts detailed in Appendix B. The light of Mars seen through the smallest hole that could be made was, after all, much greater than that of the satellite, which was the fainter of the two objects by several magnitudes. If the diameter of the hole was the hundredth part of that of the image of Mars, it is obvious that the

light transmitted would equal that of a satellite of the same reflecting power as Mars, and having one hundredth part of its diameter, or about forty miles. It is therefore evident that the equivalent diameter of the satellite, or that it would have if its albedo is the same as that of Mars, must be much less than forty miles.

In the first attempt to measure the light of the satellite, it was compared, by means of Photometer B, with the image of Mars shining through a hole of the kind just described. The results are given in Table XL. In this, and in all the subsequent tables of the volume which contain observations of satellites, one of the columns indicates the longitude of the object observed, in order to assist in detecting any variation that may take place in different portions of its orbit. Such a change is well known in the case of Iapetus, the outer satellite of Saturn. It has been explained by the hypothesis that Iapetus, like our Moon, rotates on its axis and revolves in its orbit in the same time, or always keeps the same side turned towards Saturn. If then less light is reflected from one side of the satellite than from the other, the observed variation in light would be produced. In this case, the light would be a function of the angle between the satellite and observer as seen from the planet. As precision is not required, the effect of the motion of the planet and of the Earth during a single opposition has been disregarded. The angle given is approximately equal to that described by the satellite from the point of its orbit which was in superior conjunction at the opposition of the planet.

The first four columns of Table XL. give a current number, the number of the set in Table I., the date, and the approximate time. The fifth column gives the longitude of the satellite in its orbit, as explained above. The next two columns give the designation of the hole and its diameter in seconds of arc taken from Appendix B. The seventh column gives the diameter of a circle equivalent to the disk of Mars, assuming the diameter at distance unity to be $10''.10$ (see p. 99). The next columns give the mean reading and the zero taken from Table I. The difference in magnitude of Mars and the satellite is given in the next column. The quantities from which it is derived are the diameter of Mars, M , that of the hole, H , and the mean reading, v . The ratio of the entire light of Mars to that of the portion transmitted by the hole is $\frac{M^2}{H^2}$. The ratio of the image of the latter to that of the satellite is $\cot^2 v$. The product of these ratios reduced to magnitudes will equal the difference in magnitude, m , of Mars and the satellite. Accordingly, $m = \frac{1}{0.4} \log \frac{M^2 \cot^2 v}{H^2} = 5 \log \frac{M \cot v}{H}$. Most of these observations, for reasons given on page 229, are subject to a correction. The corrected values and the residuals from the mean of 14.27 are given in the next two columns. The last column gives the initial of the observer.

The individual readings are given in the second part of Table XL. The first

and second columns are the same as in the first part of the Table. The next ten columns give the separate readings of the circle, placing together those on the same side of the zero. The order in which the observations were made was that of columns 1, 6, 2, 7, &c. The last two columns contain the mean of the readings on each side of the zero. Half the difference of these two quantities will equal the reading given in the first part of the Table, and half the sum will give the zero. For want of space, the following readings have been omitted in columns 1 to 10, although included in the means. In set 3, first part, 248.8; in set 5, first part, 205.5, 205.0, 205.0, and 207.4; in set 9, first part, 120.3, 121.2, 121.0, and 121.3, and in the second part, 119.3 and 119.6.

TABLE XL.

OBSERVATIONS OF DEIMOS WITH PHOTOMETERS B AND C.

No.	No. in Table I.	Date. 1877.	Hour.	Longi- tude.	Hole.		Equiv. Diam. of Mars.	Reading.	Zero.	Diff. in Magn.	Corr. Diff. in Magn.	Resid.	Obs.
					Design.	Diam.							
1	107	Aug. 27	11	320	A 1	0.85	26.5	4.30	162.70	13.09	14.09	-.18	P.
2	108	" "	11	320	"	"	"	3.90	161.98	13.30	14.30	+.03	S.
3	109	" "	11	320	"	"	"	3.44	251.52	13.58	14.58	+.31	P.
4	110	" "	11	320	"	"	"	4.88	72.17	12.81	13.81	-.46	U.
5	113	Aug. 28	10.5	240	B 1	1.12	26.6	2.61	202.61	13.58	14.58	+.31	R.
6	114	" "	11	240	"	"	"	2.49	22.63	13.69	14.69	+.42	R.
7	115	" "	11	240	"	"	"	2.61	49.86	13.58	13.58	-.69	P.
8	117	" "	11	240	"	"	"	3.00	328.60	13.28	13.28	-.99	P.
9	120	Aug. 30	11	90	C 4	1.81	26.7	1.04	120.14	14.55	14.55	+.28	R.
10	142	Sept. 4	11.9	90	M 2	0.36	26.8	4.17	90.97	15.05	15.05	+.78	P.
11	200	Sept. 13	10.3	120	R 3	0.36	26.2	5.44	261.12	14.42	14.42	+.15	P.
												14.27	±.42
No.	No. in Table I.	Single Readings.										Mean. First Half.	Mean. Second Half.
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.		
1	107	156.1	159.6	159.5	—	—	167.8	166.1	—	—	—	—	—
2	108	157.5	158.4	158.5	158.1	157.9	165.6	165.2	165.3	166.3	167.0	158.08	165.88
3	109	247.4	248.5	248.9	245.9	249.0	255.0	254.9	254.8	255.1	255.0	248.08	254.96
4	110	78.7	76.7	78.2	75.6	76.1	67.5	65.0	66.8	69.0	68.1	77.06	67.28
5	113	204.2	206.2	204.6	204.6	204.6	200.0	—	—	—	—	205.23	200.00
6	114	20.3	19.9	20.1	20.1	20.3	27.0	24.4	24.3	24.9	25.0	20.14	25.12
7	115	52.4	51.6	52.8	53.4	52.2	47.3	46.8	47.7	47.2	—	52.48	47.25
8	117	331.6	—	—	—	—	325.6	—	—	—	—	331.6	325.6
9	120	121.6	121.5	121.8	121.4	120.6	118.4	118.2	119.2	119.6	119.6	121.18	119.10
10	142	94.6	94.8	94.5	96.8	95.0	87.2	87.2	86.4	86.8	86.4	95.14	86.80
11	200	256.2	254.7	255.2	256.7	255.6	267.7	266.6	266.1	265.6	266.8	255.68	266.56

All the attempts to measure the satellite by this method are inserted in the above Table, although only the last three sets are free from criticism. The faintness of the satellite rendered it an extremely difficult object when the photometer was attached.

As has been shown on page 2, only .40 of the light is transmitted, or the effect is the same as if the aperture was reduced to 23 cms. The brightness would also be reduced very nearly one magnitude. On August 27, although the satellite was seen distinctly with a common eye-piece, it became quite invisible when the photometer was attached.

In set 1, care was taken that the image of Mars should be visible each time, so that as the satellite was invisible, it was certainly fainter than the image. In set 2, the image was reduced nearly to the brightness of the satellite according to the observer's recollection of its appearance with an ordinary eye-piece. In set 3, the satellite was seen at intervals, but the measures were the same as in set 1. In sets 4, 5, and 6, the image was rendered as nearly as possible equal to the satellite as recollected. In all six of these sets, the observers seem, however, to have adopted practically the same standard, which was the brightness of the satellite as seen with an ordinary eye-piece. Accordingly the same correction for the loss of light by the photometer has been applied to all by adding 1.00 to the observed difference in magnitude. Probably a similar correction should be applied to sets 7 and 8, but this has not been done, since the satellite was believed to be seen on each occasion. The record states, however, "artificial star distinctly brighter than satellite"; in the case of set 7, this accounts for the small value then obtained. In set 9 the satellite was seen several times, some of the comparisons being entirely satisfactory to the observer. When the satellite was not seen, the other image was reduced until its brightness equalled that of the satellite according to the recollection of the observer. In sets 10 and 11, the satellite was seen almost every time, although it was exceedingly faint. The last three sets are much the most satisfactory, and if these alone are used the mean difference in magnitude will equal 14.69, with an average deviation of each set of .28.

So much trouble was experienced from the loss of light caused by the photometer, that it became evident that another instrument must be devised if a satisfactory series of observations was to be obtained. Photometer D, in which the entire light of the satellite is utilized, was invented to meet this want. Table XLI. gives the measurements made with this instrument of the outer satellite Deimos, and those of the inner satellite Phobos. Throughout the Table, the first seven columns give the current number, the number in Table I., the date, the hour, the longitude of the satellite in its orbit, the mean reading, and the zero. The eighth column equals five times the logarithmic cosecant of the reading, and gives the difference in magnitude between the reflected image of Mars and the satellite. In sets 29 and 30, made with Photometer E, the logarithm of the reading itself, not of its cosecant, is employed. The ninth column gives the constant of the photometer, and equals 10.70 except in sets 23, 24, 29, and 30. In these the comparison was made with Saturn. It is therefore necessary to add to the constant the difference in magnitude of Mars and Saturn. By the

TABLE XLI.

OBSERVATIONS OF THE SATELLITES OF MARS WITH PHOTOMETERS D AND E.

No.	No. in Table I.	Date. 1877.	Hour.	Longitude.	Reading.	Zero.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Resid.	Obs.
DEIMOS.											
1	135	Sept. 4	9.2	60	9.39	254.73	3.94	10.70	14.64	— .22	P.
2	136	" "	9.5	60	7.70	72.80	4.36	"	15.06	+ .20	P.
3	139	" "	11.0	80	9.41	254.09	3.93	"	14.63	— .23	P.
4	140	" "	11.2	80	8.68	72.60	4.11	"	14.81	— .05	P.
5	141	" "	11.6	90	8.40	73.74	4.18	"	14.88	+ .02	S.
6	158	Sept. 9	9.2	40	8.55	182.73	4.14	"	14.84	— .02	P.
7	159	" "	9.3	40	9.92	3.02	3.82	"	14.52	— .34	P.
8	160	" "	9.8	50	8.52	2.44	4.15	"	14.85	— .01	S.
9	161	" "	9.9	50	9.91	181.67	3.82	"	14.52	— .34	P.
10	162	" "	10.3	60	9.33	182.29	3.95	"	14.65	— .21	P.
11	163	" "	10.5	60	10.72	2.75	3.65	"	14.35	— .51	S.
12	167	" "	11.7	70	8.45	2.51	4.16	"	14.86	.00	P.
13	169	" "	12.2	80	10.05	181.37	3.79	"	14.49	— .37	S.
14	187	Sept. 12	9.7	180	5.83	2.05	4.97	"	15.67	+ .81	P.
15	188	" "	10.5	190	6.30	2.17	4.80	"	15.50	+ .64	P.
16	189	" "	10.8	200	8.68	1.92	4.11	"	14.81	— .05	S.
17	190	" "	11.2	200	8.86	1.82	4.06	"	14.76	— .10	P.
18	198	Sept. 13	8.9	100	7.33	2.23	4.47	"	15.17	+ .31	P.
19	199	" "	9.0	100	8.61	2.69	4.12	"	14.82	— .04	S.
20	201	" "	10.8	120	6.57	1.65	4.71	"	15.41	+ .55	P.
21	202	" "	11.1	130	7.41	1.75	4.45	"	15.15	+ .29	S.
22	205	" "	11.7	130	8.84	2.08	4.07	"	14.77	— .09	P.
23	214	Sept. 16	11.5	270	35.87	.31	1.16	13.91	15.07	+ .21	P.
24	215	" "	11.6	270	29.60	4.92	1.53	"	15.44	+ .58	S.
25	217	" "	11.8	270	8.96	1.52	4.04	10.70	14.74	— .12	P.
26	218	" "	11.9	270	8.88	181.18	4.06	"	14.76	— .10	P.
27	251	Sept. 23	10.5	90	10.16	181.56	3.77	"	14.47	— .39	P.
28	252	" "	10.7	90	14.25	183.11	3.04	"	13.74	— 1.12	S.
29	414	Oct. 14	8.7	300	1.70	—	1.15	16.14	14.99	+ .13	P.
30	415	" "	8.8	300	1.47	—	0.84	"	15.30	+ .44	P.
										14.86	± .28
PHOBOS.											
1	166	Sept. 9	11.5	250	8.33	1.55	4.19	10.70	14.89	+ .33	P.
2	168	" "	12.0	280	9.40	182.86	3.93	"	14.63	+ .07	S.
3	179	Sept. 11	9.8	270	10.52	2.80	3.69	"	14.39	— .17	P.
4	180	" "	10.3	290	15.10	4.40	2.92	"	13.62	— .94	P.
5	186	Sept. 12	9.5	310	6.52	1.88	4.72	"	15.42	+ .86	P.
6	203	Sept. 13	11.3	80	9.22	1.76	3.98	"	14.68	+ .12	S.
7	204	" "	11.5	90	8.87	1.33	4.06	"	14.76	+ .20	P.
8	216	Sept. 16	11.7	240	11.97	1.61	3.42	"	14.12	— .44	P.
										14.56	± .39

method given on page 99, this was found to be 3.21 on September 16 and 2.64 on October 14. Sets 29 and 30 were made with Photometer E, and the constant accordingly equals $13.50 + 2.64 = 16.14$. With this photometer, Mars proved too bright an

TABLE XLI.

OBSERVATIONS OF THE SATELLITES OF MARS WITH PHOTOMETERS D AND E.

No.	No. in Table I.	Single Readings.										Mean. First Half.	Mean. Second Half.
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.		
DEIMOS.													
1	135	268.8	262.9	261.7	262.9	264.3	244.3	245.8	244.9	2.458	245.9	264.12	245.34
2	136	80.7	80.8	80.7	81.1	79.2	61.9	67.1	65.6	64.7	66.2	80.50	65.10
3	139	240.0	244.2	245.0	245.8	248.2	267.7	262.2	263.1	263.5	262.1	263.50	244.68
4	140	62.0	64.3	64.6	64.0	64.7	83.8	81.3	80.9	80.5	79.9	63.92	81.28
5	141	67.6	63.9	63.2	64.9	67.1	82.7	84.1	80.7	82.6	80.6	65.34	82.14
6	158	173.0	176.8	175.0	174.9	171.2	186.7	189.3	194.1	196.1	190.2	174.18	191.28
7	159	350.1	354.2	354.0	353.2	354.0	16.3	13.7	14.8	10.1	9.8	353.10	12.94
8	160	354.0	353.4	355.8	353.8	352.6	14.2	10.6	9.2	10.6	10.2	353.92	10.96
9	161	173.0	168.9	171.8	172.1	173.0	193.0	190.5	192.4	191.0	191.0	171.76	191.58
10	162	172.7	173.1	173.8	172.9	172.3	193.2	190.7	189.9	190.9	193.4	172.96	191.62
11	163	350.6	352.2	353.2	353.3	351.6	15.1	11.8	12.8	13.4	13.5	352.18	13.32
12	167	353.9	355.4	355.0	353.0	353.0	10.3	11.2	11.5	11.0	10.8	354.06	10.96
13	169	189.6	192.5	189.1	192.9	189.7	170.7	169.0	171.6	173.5	—	191.43	171.32
14	187	356.5	355.5	355.9	356.8	356.4	7.9	8.2	8.7	7.0	7.6	356.22	7.88
15	188	356.8	356.7	355.8	353.8	356.1	7.7	7.1	9.4	9.7	10.0	355.88	8.47
16	189	355.0	352.9	354.8	351.9	351.6	10.8	9.8	9.5	10.2	12.7	352.24	10.60
17	190	355.7	351.8	353.5	354.0	349.8	11.9	10.5	9.9	10.9	10.2	352.96	10.68
18	198	351.8	355.8	356.2	356.1	354.6	10.4	10.3	9.1	8.6	9.4	354.90	9.56
19	199	190.5	193.6	188.9	191.8	191.7	170.9	174.8	175.9	173.2	175.6	191.30	174.08
20	201	356.0	353.3	354.4	356.3	355.4	8.9	8.1	8.2	7.7	8.2	355.08	8.22
21	202	8.2	8.4	9.1	9.5	10.6	354.0	355.3	354.2	354.3	353.9	9.16	354.34
22	205	10.4	9.6	11.6	12.8	10.2	351.8	352.8	353.2	354.3	354.1	10.92	353.24
23	214	322.8	325.3	326.4	327.1	320.6	40.8	37.4	31.6	41.7	29.4	324.44	36.18
24	215	28.1	37.5	21.5	31.3	29.2	325.2	331.2	333.3	331.0	330.9	29.52	330.32
25	217	10.7	9.9	9.8	12.6	9.4	352.0	352.5	352.8	352.4	353.1	10.48	352.56
26	218	190.0	190.8	189.7	190.5	189.3	173.0	171.6	172.8	172.7	171.4	190.06	172.30
27	251	189.6	192.7	193.2	191.3	191.8	170.4	171.6	171.2	173.4	170.4	191.72	171.40
27	252	164.2	166.3	171.8	172.0	170.0	203.2	194.2	201.9	194.9	192.6	168.86	197.36
28	414	16.44	—	—	—	—	—	—	—	—	—	16.44	—
30	415	16.22	16.12	16.26	16.36	16.10	—	—	—	—	—	16.21	—
PHOBOS.													
1	166	11.0	9.5	10.0	9.0	9.9	350.5	352.1	353.7	354.0	355.8	9.88	353.22
2	168	174.3	174.3	175.0	172.2	171.5	190.4	192.6	192.4	193.4	192.5	173.46	192.26
3	179	11.8	11.8	14.3	16.0	12.7	352.2	350.8	353.0	351.7	353.7	13.32	352.28
4	180	349.3	—	—	—	—	19.5	—	—	—	—	349.3	19.5
5	186	8.5	8.9	8.5	8.2	7.9	354.8	355.9	354.7	355.6	355.8	8.40	355.36
6	203	350.3	352.5	353.1	353.8	353.0	12.8	12.1	9.2	10.8	10.0	352.54	10.98
7	204	353.0	350.9	351.8	353.8	352.8	9.6	10.8	8.8	11.2	10.6	352.46	10.20
8	216	347.9	352.2	350.2	346.8	351.1	15.2	12.5	13.9	14.7	11.6	349.64	13.58

object for satisfactory comparison, since it was necessary to reduce the aperture so much that the image was enlarged by diffraction. The tenth column equals the sum of the eighth and ninth columns, or their difference in sets 29 and 30, and gives the

required difference in magnitudes. The residuals of these values from the mean, (14.86 for Deimos and 14.56 for Phobos,) and the initials of the observers, are given in the last two columns.

The second part of the Table gives the separate settings. The columns have the same meaning as in the second part of Table XL. In set 3, part first, the reading 244.9 was omitted in the columns but included in the mean; 262.4 was in like manner omitted in the second part. In set 15 the readings 356.1 and 6.9 were also omitted.

The background on which the image of Mars was formed was almost perfectly black, especially when the light was reduced so as to make the images equal. That of the satellite, on the other hand, was bright and of a bluish tint, notwithstanding the red color of Mars. The reason is, that the violet light, not being brought to the same focus as the other colors, spreads out around the planet like the purplish haze surrounding any bright star. It might be thought that the eye could not compare correctly images on such different backgrounds, and that a constant source of error would thus be introduced. Accordingly, the small lantern shown at *I*, page 6, Fig. 4, was attached to the photometer, and turned so as to throw light into the auxiliary telescope. The half of the field in which the image of Mars was formed could thus be illuminated by an amount which might be varied by altering the distance of the lantern or the direction in which the light was thrown.

As the light entered between the Nicols, it did not alter as the brightness of the image of Mars was reduced. The light of the lamp was, however, much redder than that around Mars. The next step, therefore, was to insert a piece of blue glass in front of the lantern. This, however, rendered the light too blue. It was finally fastened in front of *K* by a piece of wax, so that part only of the light would pass through. The color could then be varied at will by moving the glass; the brightness was altered by moving the lantern until the two halves of the field were precisely alike, with the satellite in one, and the image of Mars in the other. These images were then placed equidistant from the black line formed by the edge of the prism, and the light of Mars reduced by turning the Nicol. This in no way altered the light of the field, but only that of the image of Mars. When the images appeared equal, the chances of systematic error were much reduced, since they had the same background and were symmetrically placed.

The advantages of this device are, however, apparent rather than real; they remove a source of criticism instead of correcting an error. A comparison of the measures with a bright and dark field shows no variations greater than those due to accidental errors. In the first thirteen sets, and in Nos. 17, 18, 19, 29, and 30, the field around Mars was dark; in 27 and 28 it was illuminated with the lantern alone; in most of the other sets the blue glass was used.

The intensity of the light from Mars seemed to render the use of an illuminated field more important with Phobos than with Deimos. A comparison of the results, however, shows no decided effect of the illumination. Sets 1 and 2 were made with a dark background, the others with a blue field, except No. 8, where the illumination is not noted. Of set 4 it is recorded, "illuminated field brighter and browner than before." During set 5, "satellite in purple haze; artificial star in bluer field than that around Mars." The results of both these sets are discordant, fortunately in opposite directions.

In Photometer D, as in Photometer H, the zero-point alters slightly when the position of the images is varied. But such a change was not likely to occur during a set of readings, and if it did (unless the change was sudden and large) the effect would be almost entirely eliminated, since the readings were taken alternately, first on one side and then on the other of the zero.

On first looking at the images in Photometer D, it was seen that they were of different colors. This effect was suspected at the time to be due to contrast; but since it was repeatedly verified by both observers under various conditions, it is believed to be a real difference, indicating that the outer satellite of Mars does not partake of the red color of the planet. It is difficult by any ordinary comparison to eliminate the effect of the great light of the primary; but under the conditions named above it is hard to understand why the difference in color should be always in one direction unless due to a real difference in color of the bodies themselves. In no case were the colors reversed, and frequently the blue color of the satellite was noted but not recorded, to avoid repetition of a fact which seemed to be established.

The following remarks regarding the color are taken from the original record. The numbers correspond to those in the first column of Table XLI. By "artificial star" is meant the image of Mars reflected in the auxiliary telescope. This is also designated as "hole," being mistaken at the moment for the portion of Mars shining through the minute hole in the previous measurements. Nos. 5, 8, 11, and 28 were made by Mr. Searle, the others by myself.

1. Mars red, satellite blue (Qy., contrast). 5. Artificial star redder than satellite. 8. No doubt hole redder than satellite. 9. Hole reddish. 11. Artificial star slightly reddish, satellite pale grayish. 12. Star decidedly red. 27. Difference in color marked, possibly due in part to color of light thrown in. 28. Reflected image of Mars yellowish, scarcely reddish if at all; satellite bluish gray, almost the color of the field.

On September 13, a wholly different method of comparing the light of the satellites was tried. Their relative light was observed directly without using Mars as a standard. Three strips of thin cover glass of different lengths were placed one over the other, so that an object could be observed through one, two, or three thicknesses.

A piece of tin-foil was attached to these so as to leave a portion near the edge exposed. This was now placed in the focus of the telescope, and viewed by a positive eye-piece. When both the satellites were visible and conveniently situated as regards Mars, the latter was brought behind the tin-foil, and the brighter of the two satellites was examined in turn through one, two or three plates of glass. Its light under these conditions was compared with that of the other satellite which was observed outside of the glass. When both satellites were viewed without obstruction, Phobos was seen to be somewhat, but not very much, the brighter; it was accordingly placed behind the glasses. On September 13, at 8^h, Phobos was close to Mars, and I then observed "they do not differ perceptibly in brightness. Inner satellite through one thickness of glass apparently faintest." At 11^h.9, however, Phobos, seen through two plates, was still brighter than Deimos, but less bright when seen through three. Regarding the number of plates as a continuous function, the number required to make the objects equal was estimated at 2.6. At 12^h.0, Mr. Searle found "the satellites nearly equal when the inner one was behind one plate, but the inner one still slightly brighter. When behind two plates it was very little fainter than the other. When behind three it was, perhaps, $\frac{3}{4}$ as bright as the outer one." On September 16, at 12^h.0, I noted, "three plates, inner decidedly fainter; two plates, inner not brighter, perhaps fainter; one plate, doubtful, prejudiced by knowing other results."

It may therefore be said, that Phobos through two plates would have very nearly the light of Deimos. Since each plate would cut off about ten per cent of the light, or reduce the brightness about one-tenth of a magnitude, we should infer from this measurement that the difference in brightness of the satellites amounted to about two-tenths of a magnitude. The discrepancies in the various estimates made by this method may be in part accounted for by the unequal distances of the two satellites from Mars.

One other method of determining the light of the satellites has been employed at the suggestion of Professor Hall. It consists in the determination at any convenient time of the magnitudes of fixed stars which have appeared approximately of equal brightness with the satellites when Mars was in their neighborhood, so that star and satellite were observed under the same conditions. The stars selected for measurement were those observed by Professor Hall on August 17 and October 2, 1877, as stated on p. 12 of his "Observations and Orbits of the Satellites of Mars," where the positions of the stars are given. They were compared with Saturn by means of Photometer I, on Dec. 23, 1877. When Mars is not near, they are not difficult objects, and could be seen in a rather small telescope; they are in fact surprisingly bright, considering that when Mars was near them they seemed as faint as the satellites.

In order to reduce the observations, we must determine the differences of magnitude between Saturn on December 23 and Mars on August 17 and October 2. The differences due to the diameters and distances of the planets are to be found as on pp. 99 and 100. With the values there adopted, the apparent diameters of Mars on August 17 and October 2 are respectively $25''.3$ and $22''.6$, including corrections for gibbosity; that of Saturn on December 23 becomes $15''.9$, including a correction for ellipticity. The logarithms of the respective ratios of these diameters are 0.202 and 0.154. The corresponding logarithms of the inverse ratio of distance from the Sun are 0.843 and 0.839. Assuming the logarithm of the albedo of Mars with respect to Saturn to be 9.335, as in Chapter III., the required differences of magnitude will be $\frac{5}{2} (0.604 + 1.685 + 9.335) = 3.56$ and $\frac{5}{2} (0.306 + 1.678 + 9.335) = 3.30$. But on December 23 the light of each star was compared with the combined light of the ball and ring of Saturn, which exceeded that of the ball alone by .13 of a magnitude; the values just obtained should therefore be reduced to 3.43 and 3.17.

When the star observed by Professor Hall on August 17 was compared with Saturn on December 23, $8^h.8$ mean time, the altitude of the planet was $37^\circ.0$, and that of the star $33^\circ.0$; the star observed October 2 was compared with Saturn on December 23, $6^h.8$ mean time, the altitudes of the planet and the star being respectively $25^\circ.0$ and $23^\circ.5$. By the method employed on p. 99, it appears that if the altitude of Saturn had been successively reduced to the altitudes of the stars compared with it, the logarithm of its light would have been diminished by 0.020 for the comparison with the star of August 17, and by 0.015 for the comparison with the other star. The corresponding reductions of magnitude are .05 and .04, which are to be subtracted from the observed differences of magnitude between Saturn and the stars; or, since the difference of magnitude between Mars and Saturn is afterwards to be added, the corrections just obtained may be subtracted from this difference, which is, accordingly, $3.43 - .05$ or 3.38 for the star of August 17, and $3.17 - .04$ or 3.13 for the other.

In Table XLII., the measurements made on December 23 are reduced. The first five columns give a current number, the number in Table I., the date, the hour, and the letter designating the star; *b* is the star observed by Professor Hall on October 2, and *a* a star preceding it about ten seconds and slightly brighter. A fainter star follows *b* a little to the north. The star observed by Professor Hall on August 17 is called in the table *f*, *g* being a brighter star a short distance south preceding. The sixth column gives the number of comparisons, the seventh the mean reading, and the eighth the constant 11.10, *minus* five times the logarithm of the mean reading, or the difference in magnitude of the star and Saturn. The ninth column gives the difference in magnitude of Saturn and Mars, and the tenth column gives the sum of the eighth and ninth, or the difference in light of Mars and the star.

This reduction is not made for stars *a* and *g*. The last column gives the initial of the observer.

TABLE XLII.
COMPARISON OF FAINT STARS WITH MARS.

No.	No. in Table I.	Date. 1877.	Hour.	Desig.	No. Obs.	Reading.	Difference in Magnitude.			Obs.
							Saturn and Star.	Mars and Saturn.	Mars and Star.	
1	1043	Dec. 23	6.7	<i>b</i>	5	.562	12.35	3.13	15.48	P.
2	1044	" "	6.8	<i>a</i>	2	.635	12.08	"	—	P.
3	1045	" "	6.9	<i>b</i>	5	.516	12.53	"	15.66	S.
4	1046	" "	7.0	<i>a</i>	2	.645	12.05	"	—	S.
5	1047	" "	8.7	<i>f</i>	5	.752	11.72	3.38	15.10	P.
6	1048	" "	8.8	<i>g</i>	2	1.125	10.85	"	—	P.
7	1049	" "	8.9	<i>f</i>	5	.750	11.72	"	15.10	P.

Professor Hall states that star *b* appeared about a quarter of a magnitude fainter than the satellite. Applying this correction gives 15.23 and 15.41 for the light of the satellite. The mean of the four sets, 1, 3, 5, and 7, is 15.21. This is somewhat greater than the previous values, or the satellite appears to be fainter. The difference is not large, considering the method. Besides the errors in the measurements of the stars, every thing depends on the single comparison of the star and satellite. Unless especial care was taken to eliminate the effect of Mars, the large error noted on page 171 might be introduced.

Comparing the results of these various measurements, we have the following determinations of the difference in light of Mars and its satellites. The eleven measurements by minute holes given in Table XL. make the difference in magnitude between Mars and Deimos 14.27 with an average deviation of .42. Only the last three sets, however, are of much value, and these make the difference in magnitude 14.69 with an average deviation of .27. In Table XLI., twenty-eight sets with Photometer D give 14.81, and two sets with Photometer E give 15.14. The entire thirty sets give 14.86 with an average deviation of .28.

Eight sets of measurements of Phobos with Photometer D give 14.56 with an average deviation of .39. From this measurement of Phobos and the comparison of the two satellites by plates of thin glass, the light of Deimos is found to be $14.56 + .20 = 14.76$ magnitudes fainter than Mars. The measurements by the aid of comparison stars give a result of 15.21.

The observations in Table XLI. are so much more numerous than any of the others, and the method is so much more satisfactory, that it seems best to adopt the values there obtained, 14.56 for Phobos and 14.86 for Deimos; the other values may be

regarded as confirmatory, some being greater and others less. If we regard the errors as wholly accidental, the probable errors in the case of Deimos will be .05, and that of Phobos .12 of a magnitude.

No marked difference is perceptible in the light of the satellites in different parts of their orbits. Of the twenty-eight sets of observations of Deimos made with Photometer D, twenty were in the eastern and eight in the western half of the orbit. The mean differences in magnitude were 14.73 and 15.09 respectively. In like manner two observations of Phobos near the eastern elongation gave 14.72, and six near the western elongation gave 14.51 for the difference in magnitude.

Table XLIII. exhibits some of the results which may be derived from the measurements given above. The first five columns contain a current number, the name of the satellite, the assumed difference in magnitude between the satellite and Mars, the logarithm of the light of the satellite in terms of the light of Mars, and the reciprocal of the corresponding number. The remainder of the Table contains various expressions for the equivalent diameter of the satellite, or the diameter which it would have if its reflecting power is the same as that of Mars. The successive units adopted to express this diameter are the diameter of Mars, the second of arc at mean distance, the second of arc at the distance of the satellite from the centre of Mars, the kilometre, and the mile. Each expression is followed by a statement of the variation which would result from a change of one-tenth of a magnitude in the third column of the Table. In the computation, the solar parallax is assumed to be 8".80, the diameter of Mars at distance unity 10".10, and the equatorial semidiameter of the Earth 6377 kilometres, or 3963 miles, the corresponding diameter of Mars being 7319 kilometres or 4548 miles.

TABLE XLIII.

DIMENSIONS OF SATELLITES OF MARS DERIVED FROM PHOTOMETRIC OBSERVATIONS.

No.	Name.	Diff. in Magn.	Log.	Ratio.	Equivalent Diameter.									
					In Diameters of Mars.		Angle at Mean Distance.		Areocentric Angle.		In Kilometres.		In Miles.	
					Adopted.	Change for 0.1 Magn.	Adopted.	Change for 0.1 Magn.	Adopt.	Change for 0.1 Magn.	Adopt.	Change for 0.1 Magn.	Adopt.	Change for 0.1 Magn.
1	Phobos	14.56	4.176	667000	.00122	.00006	''	''	197	9	8.96	.41	5.57	.26
2	Deimos	14.86	4.056	879000	.00107	.00005	.0071	.0003	69	3	7.81	.36	4.85	.22

It has been shown on page 99 that the diameter of Mars is not known with accuracy, the uncertainty amounting to at least one-tenth of the quantity to be determined.

The equivalent diameters of the satellites, whether expressed in seconds, kilometres, or miles, are consequently affected by the same degree of uncertainty; less than half of which, on the other hand, is introduced into the result by an uncertainty of one-tenth of a magnitude in the photometric comparisons. This appears from Table XLIII., the ratio of the change for one-tenth of a magnitude to the corresponding adopted value being slightly less than .05. It seems, then, unless there is some unknown source of systematic error in Table XLI., that we know the ratio between the equivalent diameters of the satellites and the diameter of Mars better than that between the diameters of Mars and the Earth. The true diameters of the satellites are probably greater, rather than less, than those assigned to them in Table XLIII., since their color seems to be darker than that of their primary. In any case, however, they must be such small objects, even as seen from Mars itself, that their phases would scarcely be recognized by the unassisted eye of an observer stationed on the planet.

The outer satellite of Mars was first seen at this Observatory on August 18, 1877. The last observation was obtained on October 14. Photometric measurements were obtained on ten evenings and micrometric measurements on fourteen, or on nineteen evenings in all. On two other evenings the satellite was seen but not measured. The light of Mars proved much more troublesome than that of the Moon. On September 23, both satellites were observed, although the Moon was near and but one day past the full. On August 29, the outer satellite was followed until after four o'clock in the morning, or nearly four hours past the meridian. Its altitude at this time was only 18° . On September 12, it was visible when nearly in conjunction with the planet. A note in the original record of set 187, Table I., states that the two satellites were then about equally distant from Mars.

The number of observations obtained two years later, at the opposition of 1879, has proved unexpectedly large. Appendix F, which contains the photometric results then obtained, has therefore been added to the present volume.

CHAPTER VIII.

SATELLITES OF JUPITER.

THE first objects selected for measurement in the series of observations described in the present volume were the satellites of Jupiter, numerous comparisons of which were obtained during the autumn of 1877 with Photometers A and B. As, however, at that time the precaution was not taken that the images should be arranged symmetrically, and later observations showed that serious errors might arise from this cause, these first comparisons will not be discussed. The material for any examination of their results which may be desired has, however, been given above in Table I. Later a series of measurements was made with Photometer E, each satellite being compared with Jupiter. On October 13, the full aperture was used; on the other dates it was reduced to 12.70 cms.

In 1878, these observations were repeated with Photometer I attached to the West Equatorial. Care was taken, as far as practicable, to observe several satellites on the same evening, and thus, since the errors would be nearly the same in all, the relative brightness of the satellites would be determined with precision.

Table XLIV. shows the results of these measurements for each year. The first five columns give the current number, the number in Table I., the date, the hour and tenth, and the corresponding longitude of the satellite in its orbit (see p. 227). The sixth column gives the reading corrected for the zero-point by the subtraction of 14.74 whenever Photometer E was the instrument employed. The seventh column gives the observed difference in magnitudes. It is found by multiplying the logarithm of the reading by five and subtracting it from the constant of the photometer. The last two columns give the residual from the mean and the initial of the observer.

The greatest difficulty in these measurements arises from the dissimilarity in the appearance of the images to be compared. That of Jupiter is well defined and round, while that of the satellite is irregular and continually varying. On Oct. 23, 1877, the air was exceptionally steady, and the comparison more satisfactory to the observers than at any other time. The measurements were made during twilight, and the satellites presented disks almost as well defined as that of Jupiter itself.

TABLE XLIV.

SATELLITES OF JUPITER. PHOTOMETERS E AND I.

No.	No. in Table I.	Date.	Hour.	Long.	Reading.	Diff. in Magn.	Resid.	Obs.
SATELLITE I. (1877.)								
1	419	Oct. 17	6.6	270	3.74	8.34	+.01	P.
2	420	" "	6.7	270	3.64	8.39	+.06	P.
3	475	Oct. 23	5.6	40	3.73	8.34	+.01	P.
4	479	" "	6.1	40	3.90	8.24	-.09	U.
5	483	" "	6.6	50	3.76	8.32	-.01	P.
						8.33	±.04	
SATELLITE I. (1878.)								
1	4384	Oct. 21	9.3	110	1.48	7.87	-.11	P.
2	4387	" "	9.4	110	1.04	8.64	+.66	S.
3	4408	Oct. 22	8.3	300	1.26	8.22	+.24	U.
4	4412	" "	8.9	310	1.63	7.66	-.32	P.
5	4428	Oct. 26	7.2	30	1.73	7.53	-.45	S.
						7.98	±.36	
SATELLITE II. (1877.)								
1	391	Oct. 13	6.2	280	10.13	8.47	+.02	P.
2	394	" "	7.0	280	6.76	9.35	+.90	U.
3	395	" "	7.2	280	10.99	8.30	-.15	P.
4	418	Oct. 17	6.6	330	4.36	8.00	-.45	P.
5	476	Oct. 23	5.7	210	3.44	8.52	+.07	P.
6	478	" "	6.0	210	3.74	8.34	-.11	U.
7	485	" "	6.8	210	4.05	8.16	-.29	P.
						8.45	±.28	
SATELLITE II. (1878.)								
1	4344	Oct. 17	9.3	230	1.59	7.71	-.55	S.
2	4389	Oct. 21	9.7	280	.95	8.83	+.57	S.
3	4390	" "	9.8	280	1.01	8.70	+.44	P.
4	4414	Oct. 24	7.5	210	1.60	7.70	-.56	P.
5	4415	" "	7.6	210	1.17	8.38	+.12	U.
						8.26	±.45	
SATELLITE III. (1877.)								
1	392	Oct. 13	6.4	240	16.88	7.36	-.26	P.
2	396	" "	7.3	250	17.99	7.22	-.40	P.
3	422	Oct. 17	6.9	90	6.52	7.13	-.49	P.
4	474	Oct. 23	5.4	20	4.59	7.89	+.27	P.
5	480	" "	6.3	30	4.18	8.09	+.47	U.
6	484	" "	6.7	30	4.32	8.02	+.40	P.
						7.62	±.38	

No.	No. in Table I.	Date.	Hour.	Long.	Reading.	Diff. in Magn.	Resid.	Obs.
SATELLITE III. (1878.)								
1	4343	Oct. 17	8.7	70	1.33	8.10	+.35	S.
2	4388	Oct. 21	9.6	270	1.53	7.80	+.05	S.
3	4391	" "	9.9	270	1.54	7.78	+.03	P.
4	4409	Oct. 22	8.3	320	1.48	7.87	+.12	U.
5	4413	" "	9.0	320	2.01	7.20	-.55	P.
						7.75	±.22	
SATELLITE IV. (1877.)								
1	393	Oct. 13	6.8	270	12.22	8.06	-.72	P.
2	397	" "	7.4	270	9.71	8.56	-.22	P.
3	421	Oct. 17	6.7	350	2.61	9.12	+.34	P.
4	477	Oct. 23	5.8	120	2.91	8.88	+.10	P.
5	481	" "	6.4	120	2.72	9.03	+.25	U.
6	482	" "	6.5	120	2.70	9.04	+.26	P.
						8.78	±.32	
SATELLITE IV. (1878.)								
1	4345	Oct. 17	9.3	280	.98	8.76	-.19	S.
2	4385	Oct. 21	9.3	10	.87	9.02	+.07	P.
3	4386	" "	9.3	10	.71	9.46	+.51	S.
4	4410	Oct. 22	8.4	30	1.07	8.57	-.38	U.
5	4411	" "	8.7	30	.90	8.95	.00	P.
						8.95	±.23	

A series of measurements was also made in 1878 with Photometer H. Each satellite was compared with each of the others on three or more nights. At least ten sets were obtained of each pair, and all the precautions were taken which the measurement of the bright double stars had suggested. The results are given in Table XLV. The columns have the same meaning as in Table IV., except that three additional columns are inserted, giving the hour and tenth, and the longitude of each of the satellites in its orbit.

PHOTOMETRIC OBSERVATIONS.

TABLE XLV.

SATELLITES OF JUPITER. PHOTOMETER H.

No.	No. in Table I.	Date.	Hour.	Longitudes.		Reading.	Diff. in Magn.	Resid.	Obs.
SATELLITES II, I. (1878.)									
1	4480	Nov. 5	4.6	340	240	40.3	.36	+.24	P.
2	4481	" "	4.7	340	240	43.1	.14	+.02	P.
3	4482	" "	4.7	340	240	40.5	.34	+.22	P.
4	4483	" "	4.8	340	240	41.2	.29	+.17	P.
5	4484	" "	5.3	340	240	43.7	.10	-.02	P.
6	4485	" "	5.3	340	240	42.8	.17	+.05	P.
7	4486	" "	6.3	340	250	46.6	-.12	-.24	S.
8	4487	" "	6.4	340	250	49.3	-.33	-.45	S.
9	4497	Nov. 6	5.3	80	90	47.4	-.18	-.30	P.
10	4498	" "	5.3	80	90	44.9	.01	-.11	P.
11	4499	" "	8.2	90	110	42.0	.23	+.11	U.
12	4500	" "	8.3	90	110	43.8	.09	-.03	U.
13	4542	Nov. 12	6.8	330	240	44.0	.08	-.04	S.
14	4543	" "	6.8	330	240	39.1	.45	+.33	S.
							.12	±.17	
SATELLITES I, III. (1878.)									
1	4213	Oct. 8	6.6	320	330	40.7	.33	.00	S.
2	4214	" "	6.7	320	330	43.0	.15	-.18	S.
3	4215	" "	6.8	320	330	41.4	.27	-.06	U.
4	4216	" "	6.8	320	330	39.7	.40	+.07	U.
5	4235	Oct. 13	5.9	250	220	39.8	.40	+.07	P.
6	4236	" "	5.9	250	220	39.6	.41	+.08	P.
7	4237	" "	6.0	250	220	41.2	.29	-.04	S.
8	4238	" "	6.0	250	220	40.8	.32	-.01	S.
9	4359	Oct. 20	6.6	240	210	38.7	.48	+.15	P.
10	4360	" "	6.7	240	210	41.2	.29	-.04	P.
							.33	±.07	
SATELLITES IV, I. (1878.)									
1	4177	Oct. 5	6.3	20	70	32.1	1.01	+.20	P.
2	4178	" "	6.3	20	70	34.8	.79	-.02	P.
3	4239	Oct. 13	6.1	190	250	36.7	.64	-.17	S.
4	4240	" "	6.2	190	250	33.3	.91	+.10	S.
5	4241	" "	6.2	190	250	32.6	.97	+.16	P.
6	4242	" "	6.2	190	250	35.7	.72	-.09	P.
7	4361	Oct. 20	6.8	340	240	32.4	.99	+.18	S.
8	4362	" "	6.9	340	240	38.3	.51	-.30	S.
9	4594	Nov. 23	7.3	350	320	31.9	1.03	+.22	P.
10	4595	" "	7.4	350	320	38.1	.53	-.28	P.
							.81	±.17	

No.	No. in Table I.	Date.	Hour.	Longitudes.		Reading.	Diff. in Magn.	Resid.	Obs.
SATELLITES II, III. (1878.)									
1	4351	Oct. 19	5.7	60	160	40.8	.32	+.08	S.
2	4352	" "	5.8	60	160	42.7	.17	-.07	S.
3	4353	" "	5.8	60	160	39.8	.40	+.16	P.
4	4636	Dec. 1	6.5	100	160	42.3	.20	-.04	P.
5	4637	" "	6.6	100	160	46.0	-.08	-.32	P.
6	4638	" "	6.7	100	160	45.1	-.01	-.25	S.
7	4639	" "	6.8	100	160	44.8	.02	-.22	S.
8	4654	Dec. 8	5.5	80	150	40.8	.32	+.08	P.
9	4655	" "	5.6	80	150	41.6	.26	+.02	P.
10	4656	" "	5.6	80	150	46.4	-.11	-.35	S.
11	4657	" "	5.7	80	150	40.0	.38	+.14	S.
12	4658	" "	5.8	80	150	45.3	-.02	-.26	S.
13	4696	Dec. 17	5.2	270	240	40.4	.35	+.11	P.
14	4697	" "	5.3	270	240	37.4	.58	+.34	P.
15	4698	" "	5.5	270	240	38.7	.48	+.24	S.
16	4699	" "	5.5	270	240	37.0	.61	+.37	S.
							.24	±.19	
SATELLITES IV, II. (1878.)									
1	4173	Oct. 5	5.7	20	80	32.3	1.00	+.32	P.
2	4174	" "	5.7	20	80	37.6	.57	-.11	P.
3	4175	" "	6.1	20	80	35.5	.73	+.05	P.
4	4176	" "	6.1	20	80	34.8	.79	+.11	P.
5	4179	" "	8.1	20	90	32.9	.95	+.27	P.
6	4180	" "	8.2	20	90	33.0	.94	+.26	P.
7	4181	" "	8.8	20	90	33.4	.90	+.22	S.
8	4182	" "	8.9	20	90	35.1	.77	+.09	S.
9	4552	Nov. 13	6.2	140	70	36.4	.66	-.02	S.
10	4553	" "	6.4	140	70	42.2	.21	-.47	S.
11	4554	" "	6.5	140	70	41.9	.24	-.44	U.
12	4555	" "	6.6	140	70	42.0	.23	-.45	U.
13	4603	Nov. 24	6.1	10	100	37.0	.61	-.07	P.
14	4604	" "	6.1	10	100	32.6	.97	+.29	P.
							.68	±.23	
SATELLITES IV, III. (1878.)									
1	4251	Oct. 14	6.2	210	270	32.8	.95	-.16	P.
2	4252	" "	6.3	210	270	32.0	1.02	-.09	P.
3	4255	" "	7.2	210	270	34.8	.79	-.32	U.
4	4256	" "	7.3	210	270	30.8	1.12	+.01	U.
5	4355	Oct. 20	6.4	340	210	27.5	1.42	+.31	P.
6	4356	" "	6.5	340	210	30.5	1.15	+.04	P.
7	4357	" "	6.5	340	210	31.3	1.08	-.03	S.
8	4358	" "	6.5	340	210	29.9	1.20	+.09	S.
9	4488	Nov. 5	6.5	330	300	30.0	1.19	+.08	S.
10	4489	" "	6.6	330	300	30.3	1.17	+.06	S.
							1.11	±.12	

The results of Table XLV. are shown in Table XLVI. The first six columns give a current number, the names of the satellites compared, the number of sets observed, the difference in magnitudes, the average deviation of a single set, and the probable error of the mean. The four satellites were treated as the components of a quadruple star, and the measurements combined according to the method of least squares by the formulas given on page 171. The letter corresponding to each measurement is given in the seventh column of Table XLVI. From these quantities we deduce $x = .73$, $y = .07$, and $z = .27$, corresponding to the differences in light of the satellites IV and II, II and I, I and III. Substituting these values gives the number in the eighth column for the computed difference in brightness of each pair of satellites. The last column gives the difference between these values and those obtained by observation in column four.

TABLE XLVI.

RESULTS OF TABLE XLV.

No.	Names.	No. Sets.	Diff. in Magn.	Av. Dev.	Prob. Error.	Desig.	Comp.	O - C.
1	II, I	14	.12	.17	.04	<i>d</i>	.07	+.05
2	I, III	10	.33	.07	.02	<i>f</i>	.27	+.06
3	IV, I	10	.81	.17	.05	<i>b</i>	.80	+.01
4	II, III	16	.24	.19	.04	<i>e</i>	.34	-.10
5	IV, II	14	.68	.23	.05	<i>a</i>	.73	-.05
6	IV, III	10	1.11	.12	.03	<i>c</i>	1.07	+.04
		74		.16	±.04			±.05

The last column of this Table shows that the various values agree very closely with one another, and that the average deviation between the observation and computation is only a twentieth of a magnitude.

A comparison of all the measures is given in Table XLVII. The first six columns give the number of the satellites, the number of sets taken in 1877 and 1878, and the resulting difference in magnitudes for each year. These quantities are obtained from Table XLIV. From the discussion of the measurements made with Photometer H, it appears that satellite III exceeds satellite I by .27 magnitudes, satellite II by .34, and satellite IV by 1.07. If, therefore, m denotes the difference in magnitude of Jupiter and satellite III, the sum of the differences in magnitude of the four satellites will equal $4m + .27 + .34 + 1.07 = 4m + 1.68$. The observations with Photometer I for 1877 make this quantity 33.18, those for 1878 make it 32.94, or the mean is 33.06. From the equation $4m + 1.68 = 33.06$, we find $m = 7.84$. The light of the other satellites is found from this by a simple addition; the results are given in column six.

The light of each satellite is thus obtained by two methods. By Photometers E and I over two hundred settings were obtained, and the light determined both in 1877 and 1878. By Photometer H nearly three hundred measurements were made in 1878, and a result obtained much freer from systematic error. Giving equal weight to these two methods, we obtain the values given in column seven, which will be adopted in the present volume. The next four columns give the average deviations of a single set, and the probable error of the mean value for the measurements in 1877 and 1878 with Photometer I. The last three columns of the Table give the residuals of columns four, five and six from column seven.

TABLE XLVII.

COMPARISON OF OBSERVATIONS OF SATELLITES OF JUPITER.

Satellite.	No. of Sets.		Differences in Magnitude.				Av. Dev.		Prob. Error.		Residuals.		
	1877.	1878.	1877.	1878.	Comp.	Adopt.	1877.	1878.	1877.	1878.	1877.	1878.	Comp.
I	5	5	8.33	7.98	8.11	8.13	.04	.36	.02	.15	+.20	-.15	-.02
II	7	5	8.45	8.26	8.18	8.27	.28	.45	.10	.19	+.18	-.01	-.09
III	6	5	7.62	7.75	7.84	7.76	.38	.22	.14	.09	-.14	-.01	+.08
IV	6	5	8.78	8.95	8.91	8.89	.32	.23	.12	.10	-.11	+.06	+.02
	24	20	33.18	32.94	33.04	33.05	.26	.32	.10	.13	±.16	±.06	±.05

It has been thought by many astronomers that the light of the satellites of Jupiter was variable. This view is not sustained by the present measurements. There is no evidence of variation of the residuals in Tables XLIV. or XLV., except that due to accidental errors. During the past two or three years, I have frequently had occasion to compare the satellites, and in no case have I been able to perceive any marked change in their relative brightness beyond that due to the proximity of Jupiter.

Table XLVIII. gives a comparison of the satellites based on the relative brightness adopted above. The first column gives the number of the satellite, and the second the assumed difference in magnitude between it and Jupiter. The third column gives the logarithm of the light of the satellite, that of Jupiter being taken as unity. This column is found from the preceding by multiplying by four-tenths, and taking the arithmetical complement of the logarithm thus found. Taking the antilogarithm, instead of the arithmetical complement, gives the number of times the light of Jupiter exceeds that of the satellite. This quantity is given in column four. The fifth column contains the equivalent diameters in terms of the mean diameter of Jupiter, which is assumed to be 192".00 at distance unity, from the data of the British Nautical Almanac. The sixth column shows the change produced in this quantity by a variation of one-

tenth of a magnitude in the assumed difference in magnitude. Columns seven and eight give the corresponding quantities in seconds of arc when the satellite is at its mean distance from the Earth, or at a distance equal to the mean distance of Jupiter from the Sun. The measured diameter of the satellite, as deduced by Engelmann in his treatise "Ueber die Helligkeitsverhältnisse der Jupiterstrabanten" (Leipzig, 1871), from a discussion of the results of various observers, is given in column nine. If the satellites had the same albedos as Jupiter, the numbers in column seven should be the same as in column nine. If the first of these quantities is the smaller, it follows that the satellite is of a darker color than the planet, or its albedo is smaller. These columns may be defined as the diameters of circles emitting the same amount of light, but having albedos equal to those of the planet and satellite. Since the albedo is inversely as the area, if we divide the number in column seven by that in column nine, and square the result, we obtain the albedo of the satellite in terms of that of the planet. This quantity, its variation for a change of one-tenth of a magnitude in the assumed difference in brightness, and its logarithm, are given in the next three columns. The last column contains the numerical value of the albedo of each satellite as deduced by Engelmann from his own observations.

TABLE XLVIII.

ALBEDO OF SATELLITES OF JUPITER DERIVED FROM PHOTOMETRIC OBSERVATIONS.

No.	Diff. in Magn.	Log.	Ratio.	Equivalent Diameter.				Meas- ured Diam- eter.	Relative Albedo.			Albedo according to Engel- mann.
				In Diameters of Jupiter.		Angle at Mean Dist.			Number.	Change for 0.1 Magn.	Log.	
				Adopted.	Change for 0.1 Magn.	Adopted.	Change for 0.1 Magn.					
I	8.13	6.748	1786	.0237	.0011	''	''	1.081	.652	.060	9.814	.2203
II	8.27	6.692	2032	.0222	.0010	.818	.038	.910	.809	.074	9.908	.2665
III	7.76	6.896	1271	.0281	.0013	1.035	.048	1.537	.453	.042	9.656	.1376
IV	8.89	6.444	3597	.0167	.0008	.615	.028	1.282	.230	.021	9.362	.0792

The value of the albedo of Jupiter assumed by Engelmann is .610, according to which the relative albedos of the satellites would be little more than half those given in Table XLVIII. On the other hand, there is a satisfactory agreement between the ratios of the albedos of the satellites themselves as determined by Engelmann's observations and by those described in this chapter. The albedos of the second, third, and fourth satellites, according to the tenth column of Table XLVIII., have respectively ratios to the albedo of the first of 1.242, .695, and .353; according to the last column, of 1.210, .625, and .359.

CHAPTER IX.

SATELLITES OF SATURN.

IN the autumn of 1877, measurements were undertaken of the light of the satellites of Saturn. The inner satellites were identified, and their positions determined by the very convenient ephemerides of Marth. It is much to be desired that similar ephemerides should be published for the three outer satellites. Measurements were obtained on twenty-eight evenings between Oct. 1, 1877, and Jan. 28, 1878, of the seven outer satellites of Saturn. Hyperion, the faintest of all, was easily observed even in strong moonlight. The minuteness of Mimas, the innermost of the satellites, and the proximity of Saturn, render it a difficult object. Although looked for repeatedly, it was not seen until Dec. 22, 1877, and was then too faint to be satisfactorily measured. It was again detected on the following evening, and its identity thus established. The cause of the difficulty was at length found in an error in the published ephemeris, which required a correction of nearly two hours. The satellite was therefore so near the ring at the predicted time of its elongation as to be almost invisible. The next year, applying this correction, Mimas was seen repeatedly in the computed position with sufficient distinctness for measurement. Generally several of the satellites were measured on the same evening to determine their relative light, and to eliminate the error incident to a direct comparison with Saturn. On the evening of Nov. 24, 1878, all eight satellites were visible. I obtained a setting of each satellite in turn, and repeated this five times. The relative brightness is thus found in a satisfactory manner.

A large number of measurements were made of Iapetus, the outer satellite, to measure the variations in light to which this body is known to be subject. Observations were made on twenty nights in the first year, and on one hundred and one in the second year. To eliminate systematic errors, the plan was adopted during the later observations of measuring on every evening a star having approximately the brightness of the satellite. The star Weisse 23^h 1013, having a position R.A. = 23^h 50^m 40^s (1880.0) and Dec. = -3° 40'.0 (1880.0) is conveniently situated for this purpose, as it is near the stationary point of Saturn, and the planet was accordingly within one or two degrees of it for several months. North preceding this star, which will be designated

as a , is another called b , of about the thirteenth magnitude, having a position R.A. = $23^h 50^m 33^s$ (1880.0) and Dec. = $-3^\circ 38'.7$ (1880.0). Star b was observed on almost every clear evening after Oct. 2, 1878, until the approach of Saturn to the Sun rendered the further measurement impossible. Some measurements were also obtained of star a . A comparison of these measurements with those of Iapetus on the same evening by the same observer eliminates many of the sources of error which otherwise might affect the result.

But few observations of Enceladus, Tethys, Dione, Rhea, and Titan were made in 1878, as it was thought that the observations of 1877 would determine their light with sufficient precision.

Ledgers of the satellites are given in Table XLIX. The first four columns give a number for reference, the number of Table I., the date, and the hour. The column headed Longitude gives approximately the angular distance the satellite has moved since its last superior conjunction with Saturn. An angle 90° therefore denotes that the satellite is at its following elongation, 270° at its preceding elongation. The next three columns give the mean reading, the product of its logarithm by five, and the constant. When the observations were made with Photometer E, the first of these quantities was corrected by subtracting the zero given in Appendix D from the reading given in Table I. The next column gives the difference in magnitude of the objects, found, as is shown on page 206, by subtracting five times the logarithm of the reading from the constant. The next column gives the correction for the ring of Saturn, found as on page 99. Subtracting these quantities from those given in the preceding column gives the next column, which equals the difference in magnitude of the satellite and ball of Saturn, supposing that the ring was removed. The residual of this quantity from its mean, and the initial of the observer, are given in the last two columns.

In the case of Iapetus the residuals are not taken from the mean, on account of the variation in light of this satellite. The difference between the observed difference of magnitude and that found by computation from the formula deduced on page 265 is given instead.

TABLE XLIX.

OBSERVATIONS OF THE SATELLITES OF SATURN.

No.	No. in Table I.	Date.	Hour.	Longitude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
MIMAS. (1878.)												
1	4042	Sept. 25	9.8	80	.83	9.60	11.10	11.50	.12	11.38	-.53	P.
2	4043	" "	10.1	90	.72	9.29	"	11.81	.12	11.69	-.22	U.
3	4261	Oct. 14	7.9	110	.67	9.13	"	11.97	.10	11.87	-.04	U.
4	4378	Oct. 21	7.6	260	.81	9.54	"	11.56	.09	11.47	-.44	U.
5	4379	" "	8.0	270	.89	9.75	"	11.35	.09	11.26	-.65	P.
6	4560	Nov. 13	9.9	80	.58	8.82	"	12.28	.07	12.21	+.30	U.
7	4562	" "	10.1	90	.64	9.03	"	12.07	.07	12.00	+.69	S.
8	4564	" "	10.3	90	.60	8.89	"	12.21	.07	12.14	+.23	P.
9	4569	" "	10.8	100	.63	9.00	"	12.10	.07	12.03	+.12	U.
10	4570	" "	10.9	100	.66	9.10	"	12.00	.07	11.93	+.02	P.
11	4577	Nov. 14	9.3	90	.54	8.66	"	12.44	.07	12.37	+.46	P.
12	4578	" "	9.3	90	.45	8.26	"	12.84	.07	12.77	+.86	U.
13	4579	" "	9.3	90	.60	8.89	"	12.21	.07	12.14	+.23	U.
14	4580	" "	9.5	100	.52	8.58	"	12.52	.07	12.45	+.54	P.
15	4597	Nov. 23	8.3	280	.89	9.75	"	11.35	.07	11.28	-.63	P.
16	4605	Nov. 24	6.3	270	.70	9.23	"	11.87	.07	11.80	-.11	P.
17	4608	" "	7.0	280	.78	9.46	"	11.64	.07	11.57	-.34	S.
18	4614	" "	7.5	290	1.02	0.04	"	11.06	.07	[10.99]		P.
19	4615	" "	7.8	290	.65	9.06	"	12.04	.07	11.97	+.06	P.
											11.91	±.33
ENCELADUS. (1877-78.)												
1	345	Oct. 7	9.7	320	2.89	2.30	13.50	11.20	.13	11.07	-.33	P.
2	346	" "	9.8	320	3.35	2.62	"	10.88	.13	10.75	-.65	S.
3	409	Oct. 13	10.0	100	2.14	1.65	"	11.85	.14	11.71	+.31	U.
4	410	" "	10.3	110	2.13	1.64	"	11.86	.14	11.72	+.32	P.
5	431	Oct. 17	8.9	60	2.57	2.05	"	11.45	.14	11.31	-.09	P.
6	436	" "	9.5	70	1.91	1.40	"	12.10	.14	11.96	+.56	U.
7	464	Oct. 22	7.7	280	2.60	2.07	"	11.43	.15	11.28	-.12	P.
8	662	Nov. 19	8.7	90	2.74	2.19	"	11.31	.16	11.15	-.25	P.
9	665	" "	9.0	90	2.57	2.05	"	11.45	.16	11.29	-.11	P.
10	4561	Nov. 13	10.0	90	.83	9.60	11.10	11.50	.07	11.43	+.03	U.
11	4563	" "	10.2	100	.78	9.46	"	11.64	.07	11.57	+.17	S.
12	4565	" "	10.3	100	.78	9.46	"	11.64	.07	11.57	+.17	P.
13	4618	Nov. 24	7.8	80	.84	9.62	"	11.48	.07	11.41	+.01	P.
											11.40	±.24
TETHYS. (1877-78.)												
1	298	Oct. 1	7.8	290	3.89	2.95	13.50	10.55	.12	10.43	-.03	P.
2	299	" "	7.8	290	3.75	2.87	"	10.63	.12	10.51	+.05	P.
3	300	" "	8.0	290	4.85	3.43	"	10.07	.12	9.95	-.51	U.
4	301	" "	8.1	290	4.70	3.36	"	10.14	.12	10.02	-.44	U.
5	302	" "	8.3	290	3.58	2.77	"	10.73	.12	10.61	+.15	S.
6	303	" "	8.5	290	3.77	2.88	"	10.62	.12	10.50	+.04	U.

No.	No. in Table I.	Date.	Hour.	Longi- tude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
TETHYS (continued).												
7	307	Oct. 1	9.3	300	4.27	3.15	13.50	10.35	.12	10.23	— .23	P.
8	311	" "	9.4	300	4.29	3.16	"	10.34	.12	10.22	— .24	S.
9	314	" "	9.8	300	5.05	3.52	"	9.98	.12	9.86	— .60	U.
10	404	Oct. 13	9.1	70	3.80	2.90	"	10.60	.14	10.46	.00	P.
11	405	" "	9.3	70	4.29	3.16	"	10.34	.14	10.20	— .26	U.
12	429	Oct. 17	8.8	110	4.06	3.04	"	10.46	.14	10.32	— .14	P.
13	435	" "	9.4	110	3.36	2.63	"	10.87	.14	10.73	+ .27	U.
14	628	Nov. 16	9.1	70	4.51	3.27	"	10.23	.16	10.07	— .39	P.
15	630	" "	9.2	70	4.82	3.41	"	10.09	.16	9.93	— .53	U.
16	667	Nov. 19	9.4	290	3.07	2.44	"	11.06	.16	10.90	+ .44	U.
17	669	" "	9.7	290	2.09	1.60	"	11.90	.16	11.74	+ 1.28	S.
18	675	Nov. 20	6.2	90	1.48	.85	"	12.65	.16	12.49	+ 2.03	S.
19	676	" "	6.4	90	3.76	2.88	"	10.62	.16	10.46	.00	P.
20	715	Dec. 1	7.0	40	1.70	1.15	11.10	9.95	.15	9.80	— .66	S.
21	1011	Dec. 22	7.1	80	1.35	.65	"	10.45	.13	10.32	— .14	P.
22	1013	" "	7.9	90	1.29	.55	"	10.55	.13	10.42	— .04	P.
23	1016	" "	8.4	90	1.08	.17	"	10.93	.13	10.80	+ .34	S.
24	4616	Nov. 24	7.8	260	1.53	.92	"	10.18	.07	10.11	— .35	P.
										10.46	± .38	
DIONE. (1877-78.)												
1	308	Oct. 1	9.3	260	3.33	2.61	13.50	10.89	.13	10.76	+ .19	P.
2	312	" "	9.4	260	3.38	2.64	"	10.86	.13	10.73	+ .16	S.
3	315	" "	9.8	260	4.18	3.11	"	10.39	.13	10.26	— .31	U.
4	330	Oct. 5	8.8	60	2.84	2.27	"	11.23	.13	11.10	+ .53	P.
5	331	" "	9.0	70	3.29	2.59	"	10.91	.13	10.78	+ .21	P.
6	332	" "	9.1	70	3.51	2.73	"	10.77	.13	10.64	+ .07	S.
7	333	" "	9.2	70	3.35	2.62	"	10.88	.13	10.75	+ .18	U.
8	408	Oct. 13	9.9	40	3.95	2.98	"	10.52	.14	10.38	— .19	U.
9	411	" "	10.3	50	4.39	3.21	"	10.29	.14	10.15	— .42	P.
10	425	Oct. 17	7.3	200	1.82	1.30	11.20	9.90	.14	9.76	— .81	U.
11	432	" "	9.0	210	2.55	2.03	13.50	11.47	.14	11.33	+ .76	P.
12	440	" "	9.7	210	2.99	2.38	"	11.12	.14	10.98	+ .41	U.
13	462	Oct. 22	7.6	140	3.86	2.93	"	10.57	.15	10.42	— .15	P.
14	550	Nov. 7	8.1	80	4.26	3.15	"	10.35	.16	10.19	— .38	P.
15	552	" "	8.3	80	4.02	3.02	"	10.48	.16	10.32	— .25	U.
16	557	" "	9.0	90	3.34	2.62	"	10.88	.16	10.72	+ .15	S.
17	4617	Nov. 24	7.8	280	1.35	.65	11.10	10.45	.07	10.38	— .19	P.
										10.57	± .32	
RHEA. (1877-78.)												
1	309	Oct. 1	9.3	240	5.58	3.73	13.50	9.77	.13	9.64	— .24	P.
2	313	" "	9.4	240	4.80	3.41	"	10.09	.13	9.96	+ .08	S.
3	316	" "	9.8	240	5.48	3.69	"	9.81	.13	9.68	— .20	U.
4	403	Oct. 13	9.0	110	4.88	3.44	"	10.06	.14	9.92	+ .04	P.
5	406	" "	9.5	110	5.87	3.84	"	9.66	.14	9.52	— .36	U.
6	424	Oct. 17	7.1	60	2.50	1.99	11.20	9.21	.14	9.07	— .81	U.
7	428	" "	8.8	70	5.44	3.68	13.50	9.82	.14	9.68	— .20	P.
8	434	" "	9.3	70	4.65	3.34	"	10.16	.14	10.02	+ .14	U.

No.	No. in Table I.	Date.	Hour.	Longi- tude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
RHEA (continued).												
9	453	Oct. 18	9.6	150	6.28	3.99	13.50	9.51	.14	9.37	— .51	P.
10	455	" "	9.7	150	4.80	3.41	"	10.09	.14	9.95	+ .07	P.
11	463	Oct. 22	7.6	100	5.59	3.74	"	9.76	.15	9.61	— .27	P.
12	703	Nov. 30	6.8	330	1.17	.34	11.10	10.76	.15	10.61	+ .73	S.
13	705	" "	7.2	330	1.01	.02	"	11.08	.15	10.93	+ 1.05	U.
14	717	Dec. 1	7.8	50	1.35	.65	"	10.45	.15	10.30	+ .42	U.
15	719	" "	8.0	50	1.85	1.34	"	9.76	.15	9.61	— .27	P.
16	4619	Nov. 24	7.8	140	1.47	.84	"	10.26	.07	10.19	+ .31	P.
										9.88	± .36	
TITAN. (1877-78.)												
1	347	Oct. 7	10.0	200	10.85	5.18	13.50	8.32	.14	8.18	— .32	P.
2	348	" "	10.1	200	8.12	4.55	"	8.95	.14	8.81	+ .31	S.
3	398	Oct. 13	7.5	330	10.91	5.19	"	8.31	.14	8.17	— .33	P.
4	401	" "	7.8	330	7.88	4.48	"	9.02	.14	8.88	+ .38	U.
5	423	Oct. 17	7.0	60	4.22	3.13	11.20	8.07	.14	7.93	— .57	U.
6	433	" "	9.1	60	11.23	5.25	13.50	8.25	.14	8.11	— .39	P.
7	442	" "	10.0	60	11.83	5.36	"	8.14	.14	8.00	— .50	U.
8	460	Oct. 22	6.4	170	7.96	4.50	"	9.00	.15	8.85	+ .35	P.
9	670	Nov. 19	9.9	90	3.14	2.48	11.20	8.72	.15	8.57	+ .07	U.
10	671	" "	9.9	90	3.62	2.79	"	8.41	.15	8.26	— .24	S.
11	672	" "	10.0	90	3.19	2.52	"	8.68	.15	8.53	+ .03	P.
12	704	Nov. 30	6.9	330	1.52	.91	11.10	10.19	.15	10.04	+ 1.54	S.
13	714	Dec. 1	6.9	0	2.41	1.91	"	9.19	.15	9.04	+ .54	S.
14	1197	Dec. 28	8.4	250	2.92	2.33	"	8.77	.13	8.64	+ .14	P.
15	3464	Aug. 7	13.5	220	3.00	2.39	"	8.71	.18	8.53	+ .03	P.
16	4586	Nov. 15	7.3	320	3.77	2.88	"	8.22	.07	8.15	— .35	P.
17	4587	" "	7.3	320	4.47	3.25	"	7.85	.07	7.78	— .72	U.
18	4620	Nov. 24	7.8	160	3.03	2.41	"	8.69	.07	8.62	+ .12	P.
										8.50	± .38	
HYPERION. (1877-78.)												
1	304	Oct. 1	8.6	240	1.18	.36	13.50	13.14	.13	13.01	+ .20	P.
2	305	" "	8.9	240	2.31	1.82	"	11.68	.13	11.55	— 1.26	S.
3	306	" "	9.1	240	.92	9.82	"	13.68	.13	13.55	+ .74	U.
4	310	" "	9.3	240	1.34	.64	"	12.86	.13	12.73	— .08	P.
5	317	" "	9.8	240	2.01	1.52	"	11.98	.13	11.85	— .96	U.
6	318	" "	10.0	240	1.09	.19	"	13.31	.13	13.18	+ .37	P.
7	319	" "	10.3	240	1.89	1.38	"	12.12	.13	11.99	— .82	S.
8	323	Oct. 5	7.5	310	1.61	1.03	"	12.47	.13	12.34	— .47	P.
9	325	" "	7.7	310	1.01	.02	"	13.48	.13	13.35	+ .54	U.
10	334	" "	9.4	310	1.53	.92	"	12.58	.13	12.45	— .36	P.
11	335	" "	9.5	310	1.37	.68	"	12.82	.13	12.69	— .12	S.
12	519	Oct. 30	7.8	10	2.13	1.64	"	11.86	.15	11.71	— 1.10	P.
13	520	" "	7.9	10	2.17	1.68	"	11.82	.15	11.67	— 1.14	U.
14	549	Nov. 7	8.0	150	1.19	.38	"	13.12	.16	12.96	+ .15	P.
15	553	" "	8.5	150	1.34	.64	"	12.86	.16	12.70	— .11	U.
16	556	" "	8.9	150	1.49	.87	"	12.63	.16	12.47	— .34	S.

No.	No. in Table I.	Date.	Hour.	Longi- tude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
HYPERION (continued).												
17	664	Nov. 19	8.9	350	1.72	1.18	13.50	12.32	.16	12.16	— .65	P.
18	3749	Sept. 7	10.0	250	.58	8.82	11.10	12.28	.15	12.13	— .68	P.
19	3750	" "	10.1	250	.44	8.22	"	12.88	.15	12.73	— .08	S.
20	3970	Sept. 20	10.5	110	.61	8.93	"	12.17	.13	12.04	— .77	P.
21	3971	" "	10.6	110	.41	8.06	"	13.04	.13	12.91	+ .10	U.
22	4120	Sept. 30	8.6	280	.28	7.24	"	13.86	.12	13.74	+ .93	S.
23	4121	" "	8.7	280	.30	7.39	"	13.71	.12	13.59	+ .78	P.
24	4140	Oct. 1	9.5	290	.34	7.66	"	13.44	.11	13.33	+ .52	P.
25	4141	" "	9.5	290	.28	7.24	"	13.86	.11	13.75	+ .94	S.
26	4377	Oct. 21	7.4	270	.47	8.36	"	12.74	.09	12.65	— .16	U.
27	4380	" "	8.3	270	.48	8.41	"	12.69	.09	12.60	— .21	P.
28	4383	" "	8.9	270	.39	7.96	"	13.14	.09	13.05	+ .24	S.
29	4407	Oct. 22	9.6	290	.48	8.41	"	12.69	.09	12.60	— .21	U.
30	4434	Oct. 28	10.8	30	.50	8.49	"	12.61	.08	12.53	— .28	P.
31	4441	Oct. 29	8.2	50	.47	8.36	"	12.74	.08	12.66	— .15	P.
32	4446	Nov. 1	6.5	100	.32	7.58	"	13.52	.08	13.44	+ .63	P.
33	4447	" "	6.7	100	.30	7.39	"	13.71	.08	13.63	+ .82	U.
34	4448	" "	7.0	100	.25	6.99	"	14.11	.08	14.03	+ 1.22	S.
35	4458	Nov. 2	8.0	110	.36	7.78	"	13.32	.08	13.24	+ .43	P.
36	4518	Nov. 7	9.3	200	.58	8.82	"	12.28	.08	12.20	— .61	P.
37	4519	" "	9.4	200	.43	8.17	"	12.93	.08	12.85	+ .04	U.
38	4566	Nov. 13	10.5	300	.45	8.27	"	12.83	.07	12.76	— .05	P.
39	4567	" "	10.6	300	.40	8.01	"	13.09	.07	13.02	+ .21	S.
40	4568	" "	10.7	300	.34	7.66	"	13.44	.07	13.37	+ .56	U.
41	4599	Nov. 23	8.5	110	.42	8.12	"	12.98	.08	12.90	+ .09	P.
42	4600	" "	8.7	110	.37	7.84	"	13.26	.08	13.18	+ .37	S.
43	4607	Nov. 24	6.7	130	.36	7.78	"	13.32	.08	13.24	+ .43	S.
44	4609	" "	7.2	130	.41	8.06	"	13.04	.08	12.96	+ .15	P.
45	4621	" "	7.8	130	.41	8.06	"	13.04	.08	12.96	+ .15	P.
										12.81	± .47	
IAPETUS. (1877-79.)												
1	256	Sept. 24	7.3	260	15.53	2.86	10.70	13.56	3.21	10.35	— .09	P.
2	266	" "	9.3	260	15.46	2.87	"	13.57	3.21	10.36	— .08	P.
3	267	" "	9.4	260	16.51	2.73	"	13.43	3.21	10.22	— .22	S.
4	324	Oct. 5	7.5	310	5.34	3.64	13.50	9.86	.13	9.73	— .73	P.
5	349	Oct. 7	10.2	320	3.91	2.96	"	10.54	.13	10.41	— .07	P.
6	350	" "	10.3	320	4.14	3.08	"	10.42	.13	10.29	— .19	S.
7	399	Oct. 13	7.6	340	4.35	3.19	"	10.31	.14	10.17	— .39	P.
8	400	" "	7.7	340	4.73	3.37	"	10.13	.14	9.99	— .57	U.
9	430	Oct. 17	8.9	0	2.63	2.10	"	11.40	.14	11.26	+ .56	P.
10	441	" "	9.8	0	2.64	2.11	"	11.39	.14	11.25	+ .55	U.
11	452	Oct. 18	9.6	10	3.80	2.90	"	10.60	.14	10.46	— .33	P.
12	454	" "	9.7	10	2.72	2.17	"	11.33	.14	11.19	+ .40	P.
13	461	Oct. 22	7.5	20	3.26	2.57	"	10.93	.15	10.78	— .13	P.
14	548	Nov. 7	7.9	100	2.50	1.99	"	11.51	.16	11.35	— .41	P.
15	551	" "	8.2	100	2.90	2.31	"	11.19	.16	11.03	— .73	U.
16	555	" "	8.7	100	4.15	3.09	"	10.41	.16	10.25	— 1.51	S.
17	626	Nov. 16	9.0	140	2.10	1.61	"	11.89	.16	11.73	+ .54	P.
18	632	" "	9.3	140	2.80	2.24	"	11.26	.16	11.10	— .09	U.
19	663	Nov. 19	8.8	150	2.96	2.36	"	11.14	.16	10.98	— .06	P.

No.	No. in Table I.	Date.	Hour.	Longi- tude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
IAPETUS (continued).												
20	666	Nov. 19	9.2	150	1.51	.89	13.50	12.61	.16	12.45	+1.41	U.
21	668	" "	9.5	150	1.93	1.43	"	12.07	.16	11.91	+ .87	S.
22	674	Nov. 20	6.0	160	1.78	1.25	"	12.25	.16	12.09	+1.18	S.
23	677	" "	6.5	160	2.14	1.65	"	11.85	.16	11.69	+ .78	P.
24	701	Nov. 30	6.6	200	1.27	.52	11.10	10.58	.15	10.43	- .13	S.
25	702	" "	6.7	200	1.03	.06	"	11.04	.15	10.89	+ .33	U.
26	713	Dec. 1	6.8	210	1.06	.13	"	10.97	.15	10.82	+ .30	S.
27	716	" "	7.5	210	1.13	.27	"	10.83	.15	10.68	+ .16	U.
28	718	" "	7.9	210	1.16	.32	"	10.78	.15	10.63	+ .11	P.
29	954	Dec. 16	9.0	280	1.35	.65	"	10.45	.14	10.31	- .13	S.
30	1012	Dec. 22	7.8	300	1.44	.79	"	10.31	.13	10.18	- .27	P.
31	1014	" "	7.9	300	1.25	.48	"	10.62	.13	10.49	+ .04	P.
32	1015	" "	8.3	300	1.34	.64	"	10.46	.13	10.33	- .12	S.
33	1042	Dec. 23	6.2	310	1.37	.68	"	10.42	.13	10.29	- .17	P.
34	1043	" "	6.3	310	1.20	.40	"	10.70	.13	10.57	+ .11	S.
35	1196	Dec. 28	8.2	330	1.26	.50	"	10.60	.13	10.47	- .05	P.
36	1259	Jan. 5	6.7	10	.93	9.84	"	11.26	.11	11.15	+ .36	P.
37	1260	" "	6.8	10	.78	9.46	"	11.64	.11	11.53	+ .74	S.
38	1301	Jan. 12	6.8	40	.85	9.65	"	11.45	.10	11.35	+ .16	S.
39	1352	Jan. 16	6.2	60	.54	8.66	"	12.44	.09	12.35	+ .83	S.
40	1353	" "	6.4	60	.73	9.32	"	11.78	.09	11.69	+ .17	P.
41	3463	Aug. 7	13.3	240	1.72	1.18	"	9.92	.18	9.74	- .71	P.
42	3465	" "	14.0	240	1.23	.45	"	10.65	.18	10.47	+ .02	S.
43	3466	" "	14.0	240	1.62	1.05	"	10.05	.18	9.87	- .58	P.
44	3543	Aug. 14	10.3	270	1.49	.87	"	10.23	.17	10.06	- .37	P.
45	3544	" "	10.3	270	.95	9.89	"	11.21	.17	11.04	+ .61	S.
46	3545	" "	10.4	270	1.41	.75	"	10.35	.17	10.18	- .25	U.
47	3659	Aug. 29	9.8	340	1.72	1.18	"	9.92	.14	9.78	- .78	P.
48	3660	" "	9.9	340	1.45	.81	"	10.29	.14	10.15	- .41	U.
49	3691	Aug. 31	9.5	350	1.30	.57	"	10.53	.14	10.39	- .23	P.
50	3709	Sept. 1	10.0	350	1.58	.99	"	10.11	.14	9.97	- .65	P.
51	3745	Sept. 6	9.8	20	.87	9.70	"	11.40	.14	11.26	+ .35	P.
52	3746	" "	9.9	20	.57	8.78	"	12.32	.14	12.18	+1.27	S.
53	3747	" "	9.9	20	.91	9.79	"	11.31	.14	11.17	+ .26	U.
54	3748	Sept. 7	9.9	20	1.01	.02	"	11.08	.13	10.95	+ .04	P.
55	3751	" "	10.2	20	.72	9.29	"	11.81	.13	11.68	+ .77	S.
56	3771	Sept. 8	10.8	30	1.18	.36	"	10.74	.13	10.61	- .43	P.
57	3772	" "	10.8	30	1.16	.32	"	10.78	.13	10.65	- .39	P.
58	3773	" "	10.9	30	.83	9.60	"	11.50	.13	11.37	+ .33	S.
59	3796	Sept. 9	10.3	30	.66	9.10	"	12.00	.13	11.87	+ .83	S.
60	3797	" "	10.3	30	.75	9.38	"	11.72	.13	11.59	+ .55	P.
61	3798	" "	10.4	30	.87	9.70	"	11.40	.13	11.27	+ .23	U.
62	3837	Sept. 14	9.8	50	.61	8.93	"	12.17	.13	12.04	+ .69	S.
63	3838	" "	9.9	50	.72	9.29	"	11.81	.13	11.68	+ .33	P.
64	3860	Sept. 15	9.7	60	.59	8.85	"	12.25	.13	12.12	+ .60	S.
65	3861	" "	9.8	60	.68	9.16	"	11.94	.13	11.81	+ .29	P.
66	3878	Sept. 16	10.0	60	.60	8.89	"	12.21	.13	12.08	+ .56	S.
67	3879	" "	10.1	60	.72	9.29	"	11.81	.13	11.68	+ .16	U.
68	3880	" "	10.2	60	.74	9.35	"	11.75	.13	11.62	+ .10	P.
69	3896	Sept. 17	8.9	70	.56	8.74	"	12.36	.13	12.23	+ .57	S.
70	3897	" "	9.0	70	.74	9.35	"	11.75	.13	11.62	- .04	P.
71	3898	" "	9.1	70	.75	9.38	"	11.72	.13	11.59	- .07	U.
72	3927	Sept. 18	10.1	70	.64	9.03	"	12.07	.13	11.94	+ .28	P.
73	3928	" "	10.2	70	.72	9.29	"	11.81	.13	11.68	+ .02	S.

No.	No. in Table I.	Date.	Hour.	Longi- tude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
IAPETUS (continued).												
74	3929	Sept. 18	10.3	70	.76	9.40	11.10	11.70	.13	11.57	— .09	U.
75	3944	Sept. 19	10.0	80	.95	9.89	"	11.21	.13	11.08	— .68	U.
76	3945	" "	10.0	80	.85	9.65	"	11.45	.13	11.32	— .44	S.
77	3946	" "	10.1	80	.87	9.70	"	11.40	.13	11.27	— .49	P.
78	3972	Sept. 20	10.7	80	.92	9.82	"	11.28	.13	11.15	— .61	U.
79	3973	" "	10.7	80	.93	9.84	"	11.26	.13	11.13	— .63	P.
80	3996	Sept. 22	9.3	90	.77	9.43	"	11.67	.12	11.55	— .25	P.
81	3997	" "	9.3	90	.63	9.00	"	12.10	.12	11.98	+ .18	S.
82	4016	Sept. 23	9.4	90	2.01	1.52	"	9.58	.12	9.46	— 2.34	P.
83	4017	" "	9.5	90	2.24	1.75	"	9.35	.12	9.23	— 2.57	U.
84	4044	Sept. 25	10.3	100	1.04	.08	"	11.02	.12	10.90	— .86	S.
85	4045	" "	10.5	100	.84	9.62	"	11.48	.12	11.36	— .40	P.
86	4046	" "	10.6	100	.87	9.70	"	11.40	.12	11.28	— .48	U.
87	4058	Sept. 27	8.9	110	.90	9.77	"	11.33	.12	11.21	— .45	U.
88	4059	" "	9.0	110	.77	9.43	"	11.67	.12	11.55	— .11	P.
89	4080	Sept. 28	9.1	120	.89	9.75	"	11.35	.12	11.23	— .29	P.
90	4081	" "	9.2	120	.74	9.35	"	11.75	.12	11.63	+ .11	S.
91	4100	Sept. 29	8.7	120	.90	9.77	"	11.33	.12	11.21	— .31	P.
92	4101	" "	8.9	120	.80	9.52	"	11.58	.12	11.46	— .06	S.
93	4118	Sept 30	8.1	130	.89	9.75	"	11.35	.12	11.23	— .12	P.
94	4119	" "	8.2	130	.79	9.49	"	11.61	.12	11.49	+ .14	S.
95	4138	Oct. 1	9.3	130	.69	9.19	"	11.91	.12	11.79	+ .44	S.
96	4139	" "	9.3	130	.82	9.57	"	11.53	.12	11.41	+ .06	P.
97	4149	Oct. 2	8.8	140	.86	9.67	"	11.43	.11	11.32	+ .13	P.
98	4150	" "	8.8	140	.74	9.35	"	11.75	.11	11.64	+ .45	S.
99	4168	Oct. 4	9.8	150	.84	9.62	"	11.48	.11	11.37	+ .33	S.
100	4169	" "	9.9	150	.80	9.52	"	11.58	.11	11.47	+ .43	P.
101	4187	Oct. 6	7.2	160	.61	8.93	"	12.17	.11	12.06	+ 1.15	S.
102	4188	" "	7.8	160	.73	9.32	"	11.78	.11	11.67	+ .76	P.
103	4191	" "	8.3	160	.67	9.13	"	11.97	.11	11.86	+ .95	S.
104	4227	Oct. 10	8.5	170	.85	9.65	"	11.45	.10	11.35	+ .56	P.
105	4230	" "	8.8	170	1.22	.43	"	10.67	.10	10.57	— .22	U.
106	4231	" "	9.8	170	.94	9.87	"	11.23	.10	11.13	+ .34	S.
107	4245	Oct. 13	6.8	190	1.23	.45	"	10.65	.10	10.55	— .07	P.
108	4248	" "	7.6	190	1.24	.47	"	10.63	.10	10.53	— .09	S.
109	4253	Oct. 14	6.9	190	1.17	.34	"	10.76	.10	10.66	+ .04	U.
110	4259	" "	7.7	190	1.34	.64	"	10.46	.10	10.36	— .26	P.
111	4262	" "	8.5	190	1.24	.47	"	10.63	.10	10.53	— .09	S.
112	4282	Oct. 15	8.8	200	1.09	.19	"	10.91	.10	10.81	+ .25	U.
113	4283	" "	8.9	200	1.58	.99	"	10.11	.10	10.01	— .55	S.
114	4287	" "	9.1	200	1.51	.89	"	10.21	.10	10.11	— .45	P.
115	4301	Oct. 16	7.2	200	1.70	1.15	"	9.95	.10	9.85	— .71	U.
116	4306	" "	7.7	200	1.43	.78	"	10.32	.10	10.22	— .34	P.
117	4319	Oct. 17	7.3	210	2.39	1.89	"	9.21	.09	9.12	— 1.40	S.
118	4320	" "	7.4	210	1.34	.64	"	10.46	.09	10.37	— .15	U.
119	4323	" "	7.6	210	2.00	1.50	"	9.60	.09	9.51	— 1.01	P.
120	4364	Oct. 20	8.3	220	1.83	1.31	"	9.79	.09	9.70	— .78	S.
121	4365	" "	8.4	220	1.78	1.25	"	9.85	.09	9.76	— .72	P.
122	4373	Oct. 21	7.0	220	2.02	1.53	"	9.57	.09	9.48	— 1.00	S.
123	4376	" "	7.3	220	1.48	.85	"	10.25	.09	10.16	— .32	U.
124	4381	" "	8.3	220	1.93	1.43	"	9.67	.09	9.58	— .90	P.
125	4392	" "	10.0	220	.61	8.93	8.72	9.79	.09	9.70	— .78	P.
126	4393	Oct. 22	6.1	230	1.69	1.14	11.10	9.96	.09	9.87	— .59	P.
127	4396	" "	6.3	230	1.74	1.20	"	9.90	.09	9.81	— .65	S.

No.	No. in Table I.	Date.	Hour.	Longi- tude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
IAPETUS (continued).												
128	4397	Oct. 22	6.5	230	1.65	1.09	11.10	10.01	.09	9.92	— .54	U.
129	4420	Oct. 26	7.4	250	1.52	.91	"	10.19	.08	10.11	— .33	P.
130	4432	Oct. 28	10.6	260	1.43	.78	"	10.32	.08	10.24	— .20	P.
131	4438	Oct. 29	8.1	260	1.64	1.07	"	10.03	.08	9.95	— .49	U.
132	4439	" "	8.1	260	1.73	1.19	"	9.91	.08	9.83	— .61	P.
133	4444	" "	9.6	260	1.75	1.21	"	9.89	.08	9.81	— .63	S.
134	4449	Nov. 1	7.1	270	1.23	.45	"	10.65	.08	10.57	+ .14	S.
135	4452	" "	7.2	270	1.25	.48	"	10.62	.08	10.54	+ .11	P.
136	4453	" "	7.3	270	1.40	.73	"	10.37	.08	10.29	— .14	U.
137	4455	Nov. 2	7.7	280	1.46	.82	"	10.28	.08	10.20	— .24	P.
138	4467	Nov. 3	6.0	280	1.39	.71	"	10.39	.08	10.31	— .13	P.
139	4470	" "	6.2	280	.79	9.49	"	11.61	.08	11.53	+ .09	S.
140	4471	Nov. 4	7.8	290	1.31	.59	"	10.51	.08	10.43	— .01	P.
141	4474	" "	8.0	290	1.19	.38	"	10.72	.08	10.64	+ .20	U.
142	4475	" "	9.5	290	1.18	.36	"	10.74	.08	10.66	+ .22	S.
143	4533	Nov. 8	6.6	310	1.32	.60	"	10.50	.07	10.43	— .03	S.
144	4534	" "	6.8	310	1.48	.85	"	10.25	.07	10.18	— .28	P.
145	4537	" "	7.4	310	1.10	.21	"	10.89	.07	10.82	+ .36	U.
146	4538	Nov. 10	5.8	320	1.47	.84	"	10.26	.07	10.19	— .29	P.
147	4541	" "	6.0	320	1.41	.75	"	10.35	.07	10.28	— .20	S.
148	4548	Nov. 12	7.7	330	1.55	.95	"	10.15	.07	10.08	— .44	P.
149	4551	" "	7.8	330	1.41	.75	"	10.35	.07	10.28	— .24	U.
150	4557	Nov. 13	6.9	330	1.48	.85	"	10.25	.07	10.18	— .34	S.
151	4559	" "	7.2	330	1.59	1.01	"	10.09	.07	10.02	— .50	U.
152	4572	Nov. 14	6.7	330	1.40	.73	"	10.37	.07	10.30	— .22	P.
153	4573	" "	6.7	330	1.32	.60	"	10.50	.07	10.43	— .09	S.
154	4576	" "	7.2	330	1.59	1.01	"	10.09	.07	10.02	— .50	U.
155	4584	Nov. 15	7.2	340	1.29	.55	"	10.55	.07	10.48	— .08	P.
156	4588	" "	7.4	340	1.23	.45	"	10.65	.07	10.58	+ .02	U.
157	4590	Nov. 16	7.8	340	1.39	.71	"	10.39	.07	10.32	— .24	P.
158	4592	" "	8.3	340	1.42	.76	"	10.34	.07	10.27	— .29	S.
159	4598	Nov. 23	8.5	20	1.14	.28	"	10.82	.07	10.75	— .16	P.
160	4601	" "	8.8	20	.96	9.91	"	11.19	.07	11.12	+ .21	S.
161	4606	Nov. 24	6.6	20	1.29	.55	"	10.55	.07	10.48	— .43	S.
162	4610	" "	7.2	20	1.11	.23	"	10.87	.07	10.80	— .11	P.
163	4622	" "	7.8	20	1.01	.02	"	11.08	.07	11.01	+ .10	P.
164	4623	Nov. 26	6.8	30	1.19	.38	"	10.72	.07	10.65	— .39	U.
165	4626	" "	7.1	30	.80	9.52	"	11.58	.07	11.51	+ .47	P.
166	4627	Nov. 29	5.6	40	.69	9.19	"	11.91	.07	11.84	+ .65	P.
167	4629	" "	5.7	40	1.04	.08	"	11.02	.07	10.95	— .24	S.
168	4631	" "	8.9	40	1.18	.36	"	10.74	.07	10.67	— .52	S.
169	4632	Nov. 30	6.0	50	1.03	.06	"	11.04	.07	10.97	— .38	S.
170	4635	" "	6.2	50	1.04	.08	"	11.02	.07	10.95	— .40	P.
171	4640	Dec. 1	8.6	50	.61	8.93	"	12.17	.07	12.10	+ .75	S.
172	4641	" "	8.6	50	.94	9.87	"	11.23	.07	11.16	— .19	P.
173	4644	Dec. 6	6.3	70	.66	9.10	"	12.00	.07	11.93	+ .27	S.
174	4647	" "	6.4	70	.67	9.13	"	11.97	.07	11.90	+ .24	P.
175	4648	" "	6.5	70	.80	9.52	"	11.58	.07	11.51	— .15	U.
176	4659	Dec. 8	6.2	80	.61	8.93	"	12.17	.07	12.10	+ .34	P.
177	4662	" "	6.3	80	.60	8.89	"	12.21	.07	12.14	+ .38	S.
178	4663	Dec. 11	7.4	100	.92	9.82	"	11.28	.08	11.20	— .56	U.
179	4665	Dec. 13	6.4	110	2.45	1.95	14.00	12.05	.08	11.97	+ .31	S.
180	4668	" "	6.7	110	2.98	2.37	"	11.63	.08	11.55	— .11	U.
181	4669	" "	6.9	110	.78	9.46	11.10	11.64	.08	11.56	— .10	S.

No.	No. in Table I.	Date.	Hour.	Longi- tude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
IAPETUS (continued).												
182	4672	Dec. 13	7.2	110	.72	9.29	11.10	11.81	.08	11.73	+ .07	U.
183	4674	Dec. 14	5.6	110	.87	9.70	"	11.40	.08	11.32	- .34	P.
184	4675	" "	5.6	110	.73	9.32	"	11.78	.08	11.70	+ .04	S.
185	4678	" "	6.0	110	2.79	2.23	14.00	11.77	.08	11.69	+ .03	P.
186	4679	" "	6.0	110	2.73	2.18	"	11.82	.08	11.74	+ .08	S.
187	4681	Dec. 16	6.0	120	3.33	2.61	"	11.39	.08	11.31	- .21	P.
188	4684	" "	6.3	120	3.23	2.55	"	11.45	.08	11.37	- .15	S.
189	4686	" "	6.5	120	.79	9.49	11.10	11.61	.08	11.53	+ .01	P.
190	4687	" "	6.5	120	.76	9.40	"	11.70	.08	11.62	+ .10	S.
191	4689	" "	6.7	120	.85	9.65	"	11.45	.08	11.37	- .15	U.
192	4691	" "	7.0	120	2.35	1.86	14.00	12.14	.08	12.06	+ .54	U.
193	4700	Dec. 17	9.3	120	.89	9.75	11.10	11.35	.08	11.27	- .25	P.
194	4702	" "	9.5	120	.79	9.49	"	11.61	.08	11.53	+ .01	U.
195	4704	" "	9.7	120	3.89	2.95	14.00	11.05	.08	10.97	- .55	P.
196	4706	" "	9.8	120	3.24	2.55	"	11.45	.08	11.37	- .15	U.
197	4708	Dec. 18	5.7	130	2.71	2.16	"	11.84	.08	11.76	+ .41	P.
198	4710	" "	6.0	130	.61	8.93	11.10	12.17	.08	12.09	+ .74	P.
199	4716	" "	6.7	130	2.21	1.72	14.00	12.28	.08	12.20	+ .85	U.
200	4718	" "	8.3	130	.92	9.82	11.10	11.28	.08	11.20	- .15	U.
201	4720	Dec. 19	7.1	130	.97	9.93	"	11.17	.08	11.09	- .26	U.
202	4722	" "	7.3	130	2.77	2.21	14.00	11.79	.08	11.71	+ .36	U.
203	4725	" "	7.6	130	3.04	2.41	"	11.59	.08	11.51	+ .16	P.
204	4727	" "	7.7	130	.70	9.23	11.10	11.87	.08	11.79	+ .44	P.
205	4729	Dec. 20	8.0	140	3.12	2.47	14.00	11.53	.08	11.45	+ .26	P.
206	4730	" "	8.2	140	.77	9.43	11.10	11.67	.08	11.59	+ .40	P.
207	4732	Dec. 22	8.2	150	.72	9.29	"	11.81	.09	11.72	+ .68	P.
208	4734	Dec. 23	6.6	150	.77	9.43	"	11.67	.09	11.58	+ .54	P.
209	4737	" "	6.8	150	.76	9.40	"	11.70	.09	11.61	+ .57	U.
210	4738	" "	7.1	150	3.42	2.67	14.00	11.33	.09	11.24	+ .20	U.
211	4741	" "	7.4	150	3.59	2.78	"	11.22	.09	11.13	+ .09	P.
212	4742	Dec. 24	7.0	160	.94	9.87	11.10	11.23	.09	11.14	+ .23	U.
213	4745	" "	7.2	160	1.16	.32	"	10.78	.09	10.69	- .22	P.
214	4747	" "	7.4	160	3.67	2.82	14.00	11.18	.09	11.09	+ .18	P.
215	4748	" "	7.5	160	3.29	2.59	"	11.41	.09	11.32	+ .41	U.
216	4751	Dec. 25	6.1	160	4.80	3.41	"	10.59	.09	10.50	- .41	P.
217	4752	" "	6.2	160	.82	9.57	11.10	11.53	.09	11.44	+ .53	P.
218	4755	" "	6.5	160	.94	9.87	"	11.23	.09	11.14	+ .23	U.
219	4756	" "	7.3	160	3.76	2.88	14.00	11.12	.09	11.03	+ .12	U.
220	4758	Dec. 26	6.2	160	4.03	3.03	"	10.97	.09	10.88	- .03	P.
221	4761	" "	6.7	160	4.02	3.02	"	10.98	.09	10.89	- .02	U.
222	4762	" "	6.8	160	1.26	.50	11.10	10.60	.09	10.51	- .40	U.
223	4767	" "	7.1	160	1.25	.48	"	10.62	.09	10.53	- .38	P.
224	4768	Dec. 28	9.4	170	1.04	.08	"	11.02	.09	10.93	+ .14	P.
225	4770	Dec. 29	5.9	180	1.06	.13	"	10.97	.09	10.88	+ .18	P.
226	4772	Dec. 30	7.7	180	1.06	.13	"	10.97	.09	10.88	+ .18	U.
227	4775	" "	8.1	180	1.23	.45	"	10.65	.09	10.56	- .14	P.
228	4776	" "	8.5	180	3.98	3.00	14.00	11.00	.09	10.91	+ .21	U.
229	4779	Dec. 31	6.0	190	1.13	.27	11.10	10.83	.09	10.74	+ .12	P.
230	4780	" "	6.7	190	1.22	.43	"	10.67	.09	10.58	- .04	U.
231	4782	Jan. 3	5.8	200	1.41	.75	"	10.35	.09	10.26	- .30	S.
232	4785	" "	6.1	200	1.23	.45	"	10.65	.09	10.56	.00	P.
233	4786	" "	6.3	200	4.20	3.12	14.00	10.88	.09	10.79	+ .23	S.
234	4788	Jan. 5	5.6	210	1.25	.48	11.10	10.62	.10	10.52	.00	S.
235	4791	" "	6.4	210	3.49	2.71	14.00	11.29	.10	11.19	+ .67	S.

No.	No. in Table I.	Date.	Hour.	Longi- tude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
IAPETUS (continued).												
236	4793	Jan. 5	6.7	210	1.14	.28	11.10	10.82	.10	10.72	+ .20	P.
237	4794	Jan. 6	7.1	210	3.45	2.69	14.00	11.31	.10	11.21	+ .69	S.
238	4796	" "	7.4	210	1.18	.36	11.10	10.74	.10	10.64	+ .12	S.
239	4800	" "	7.8	210	.77	9.43	"	11.67	.10	11.57	+ 1.05	U.
240	4801	" "	7.9	210	1.17	.34	"	10.76	.10	10.66	+ .14	P.
241	4802	Jan. 7	5.9	220	1.67	1.11	"	9.99	.10	9.89	- .59	S.
242	4805	" "	6.2	220	1.65	1.09	"	10.01	.10	9.91	- .57	P.
243	4806	" "	6.4	220	5.67	3.77	14.00	10.23	.10	10.13	- .35	S.
244	4808	" "	6.7	220	1.43	.78	11.10	10.32	.10	10.22	- .26	U.
245	4810	Jan. 10	5.7	230	.75	9.38	"	11.72	.11	11.61	+ 1.15	S.
246	4813	" "	5.9	230	1.07	.15	"	10.95	.11	10.84	+ .38	P.
247	4814	Jan. 12	6.4	240	1.05	.11	"	10.99	.11	10.88	+ .43	P.
248	4817	" "	6.7	240	1.03	.06	"	11.04	.11	10.93	+ .48	S.
249	4818	" "	7.0	240	3.53	2.74	14.00	11.26	.11	11.15	+ .70	S.
250	4820	Jan. 13	7.4	250	2.15	1.66	11.10	9.44	.11	9.33	- 1.11	U.
251	4821	" "	7.5	250	1.47	.84	"	10.26	.11	10.15	- .29	P.
252	4824	" "	8.3	250	1.59	1.01	"	10.09	.11	9.98	- .46	S.
253	4826	Jan. 18	5.8	270	3.54	2.74	14.00	11.26	.12	11.14	+ .71	S.
254	4828	" "	6.3	270	1.27	.52	11.10	10.58	.12	10.46	+ .03	S.
255	4831	" "	6.5	270	1.64	1.07	"	10.03	.12	9.91	- .52	P.
256	4832	Jan. 19	5.7	270	1.37	.68	"	10.42	.12	10.30	- .13	P.
257	4833	" "	5.9	270	.90	9.77	"	11.33	.12	11.21	+ .78	S.
258	4836	" "	6.3	270	3.19	2.52	14.00	11.48	.12	11.36	+ .93	S.
259	4838	Jan. 20	5.9	280	1.10	.21	11.10	10.89	.12	10.77	+ .33	P.
260	4839	" "	6.0	280	.82	9.57	"	11.53	.12	11.41	+ .97	S.
261	4842	Jan. 23	6.2	290	2.14	1.65	"	9.45	.12	9.33	- 1.11	P.
262	4845	" "	6.5	290	1.33	.62	"	10.48	.12	10.36	- .08	S.
263	4846	" "	6.8	290	1.26	.50	"	10.60	.12	10.48	+ .04	U.
264	4848	Jan. 24	7.0	300	1.65	1.09	"	10.01	.13	9.88	- .57	P.
265	4849	" "	7.0	300	1.56	.97	"	10.13	.13	10.00	- .45	U.
266	4850	Jan. 25	6.4	300	1.29	.55	"	10.55	.13	10.42	- .03	P.
267	4853	" "	6.7	300	.82	9.57	"	11.53	.13	11.40	+ .95	S.
268	4854	Jan. 26	5.9	310	1.17	.34	"	10.76	.13	10.63	+ .17	P.
269	4855	" "	6.0	310	.76	9.40	"	11.70	.13	11.57	+ 1.11	S.
270	4858	Jan. 29	6.1	320	1.16	.32	"	10.78	.13	10.65	+ .17	P.
271	4859	" "	6.2	320	.91	9.79	"	11.31	.13	11.18	+ .70	S.
272	4862	Jan. 30	6.2	320	1.10	.21	"	10.89	.14	10.75	+ .27	P.
273	4865	" "	6.4	320	1.25	.48	"	10.62	.14	10.48	.00	S.
274	4866	" "	6.7	320	1.44	.79	"	10.31	.14	10.17	- .31	U.
275	4868	Jan. 31	7.2	330	1.10	.21	"	10.89	.14	10.75	+ .23	S.
276	4871	" "	7.5	330	1.21	.41	"	10.69	.14	10.55	+ .03	U.
277	4872	" "	7.5	330	1.16	.32	"	10.78	.14	10.64	+ .12	P.
278	4874	Feb. 3	6.4	340	1.23	.45	"	10.65	.14	10.51	- .05	S.
279	4875	" "	6.4	340	1.18	.36	"	10.74	.14	10.60	+ .04	P.
280	4876	Feb. 4	6.1	350	1.04	.08	"	11.02	.14	10.88	+ .26	P.
281	4879	" "	6.6	350	.53	8.62	"	12.48	.14	12.34	+ 1.72	S.
282	4880	" "	6.7	350	.95	9.89	"	11.21	.14	11.07	+ .45	S.
283	4881	" "	6.8	350	1.21	.41	"	10.69	.14	10.55	- .07	U.
284	4882	" "	6.9	350	.96	9.91	"	11.19	.14	11.05	+ .43	U.
285	4884	Feb. 7	6.3	0	.83	9.60	"	11.50	.15	11.35	+ .65	S.
286	4885	" "	6.4	0	1.04	.08	"	11.02	.15	10.87	+ .17	P.
287	4888	" "	6.8	0	.96	9.91	"	11.19	.15	11.04	+ .34	U.
288	4893	Feb. 8	6.7	0	.85	9.65	"	11.45	.15	11.30	+ .60	P.
289	4895	Feb. 9	6.2	10	.89	9.75	"	11.35	.15	11.20	+ .41	P.

No.	No. in Table I.	Date.	Hour.	Longi- tude.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring.	Corr. Diff. in Magn.	Resid.	Obs.
IAPETUS (continued).												
290	4896	Feb. 9	6.8	10	.90	9.77	11.10	11.33	.15	11.18	+ .39	S.
291	4903	Feb. 10	6.5	10	.80	9.52	"	11.58	.15	11.43	+ .64	P.
292	4906	Feb. 12	6.8	20	1.00	.00	"	11.10	.16	10.94	+ .03	S.
293	4909	" "	7.2	20	.94	9.87	"	11.23	.16	11.07	+ .16	U.
294	4910	Feb. 14	6.3	30	.87	9.70	"	11.40	.16	11.24	+ .20	P.
295	4911	" "	6.4	30	.51	8.54	"	12.56	.16	12.40	+ 1.36	S.
296	4912	" "	6.6	30	.69	9.19	"	11.91	.16	11.75	+ .71	S.
297	4913	" "	6.6	30	.94	9.87	"	11.23	.16	11.07	+ .03	P.
298	4921	" "	7.2	30	.82	9.57	"	11.53	.16	11.37	+ .33	U.
299	4922	" "	7.3	30	.88	9.72	"	11.38	.16	11.22	+ .18	U.
300	4925	Feb. 15	6.7	40	.52	8.58	"	12.52	.16	12.36	+ 1.17	S.
301	4926	" "	6.8	40	.87	9.70	"	11.40	.16	11.24	+ .05	P.
302	4927	" "	6.9	40	.85	9.65	"	11.45	.16	11.29	+ .10	S.
303	4928	" "	6.9	40	1.05	.11	"	10.99	.16	10.83	- .36	P.
											± .39	

The observations made with Photometer D, which have already been used in Table XXIV., have been omitted in Table XLIX. As they have served to determine the constant of the photometer, it did not seem advisable to use them a second time in measuring the light of the satellite. This objection does not apply to the measurements of Iapetus with Photometer D, which are therefore inserted, and reduced in the manner already described. As the comparison is made with Mars instead of Saturn, the difference in magnitude between Mars and the ball of Saturn is inserted in the tenth column instead of the correction for the ring. Set 18 of the measures of Mimas is not used in the mean. It consisted of a single setting which was seen to be too large, and the set was accordingly recommenced. Giving it a weight proportional to the number of settings, it would, if retained, only diminish the mean by one one-hundredth of a magnitude. Sets 17 and 18 of Tethys evidently make the satellite too faint; but they are retained, since no sufficient reason can be offered for their rejection. Other observations on the same evening give to the satellite its usual brightness. A curious discrepancy is found in sets 82 and 83 of Iapetus. The satellite appeared unusually bright, and large readings were obtained both by Mr. Upton and myself. As the law of variation of the light was not at that time known, it was assumed that the satellite had attained its full brightness suddenly. The following sets, however, show that the true brightness was probably less by two magnitudes than that observed. It is possible that a star was used for comparison instead of Saturn; but this does not seem probable, as no star of sufficient brightness was near.

The measurements of stars *a* and *b* are given in Table L. The columns have in

general the same meaning as in Table XLIX. The column giving the longitude is omitted, and that giving the correction for the ring contains also a correction for the distance of Saturn. The correction for the distances of the satellites is the same as that for Saturn, and therefore need not be applied in Table XLIX. But since the light of a star is independent of the position of the planet, we must in Table L. reduce the light of Saturn to that which it would have when at its mean distance from the Sun and Earth.

Let S represent the light of Saturn at a distance r from the Sun and a distance Δ from the Earth; let S_0 denote its light when at its mean distance a from each. Then $S_0 = S \frac{r^2 \Delta^2}{a^4}$, and the difference in magnitude of S_0 and S will equal $2.5 (\log S - \log S_0) = 5 (2 \log a - \log r - \log \Delta)$. This correction added to the correction for the ring is that given in the tenth column.

Two additional columns have been added to the Table to show the corresponding measures of Iapetus. They give the difference in brightness of Iapetus and the star, when both are measured on the same night by the same observer. A positive sign denotes that Iapetus is the fainter. When an observer obtained more than one set in an evening, the comparison was made between those in which the conditions were as nearly as possible the same, as, for instance, with the same photometer, with the prism in the same position, or with star a out of the field. The last column gives the residual from a value obtained by computation, by means of the formula given on page 265. The mean of the two corresponding observations of Iapetus has been used in sets 4 and 14 of star a , and sets 60 and 64 of star b . In reducing set 4 of star b , No. 4191 is used instead of 4187, as the latter was interrupted by clouds, and contains only three readings.

TABLE L.
COMPARISONS OF STARS WITH SATURN.

No.	No. in Table I.	Date.	Hour.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring and Dist.	Corr. Diff. in Magn.	Resid.	Obs.	Iapetus — Star.	Resid.
STAR <i>a.</i> (1878.)													
1	4145	Oct. 2	8.5	2.19	1.70	11.10	9.40	— .35	9.05	+ .53	S.	+ 2.59	— .12
2	4148	" "	8.6	2.82	2.25	"	8.85	— .35	8.50	— .02	P.	+ 2.82	+ .11
3	4190	Oct. 6	8.0	2.27	1.78	"	9.32	— .34	8.98	+ .46	P.	+ 2.69	+ .26
4	4192	" "	8.5	1.79	1.26	"	9.84	— .34	9.50	+ .98	S.	+ 2.36	— .07
5	4247	Oct. 13	7.0	1.78	1.25	"	9.85	— .32	9.53	+ 1.01	S.	+ 1.00	— 1.14
6	4250	" "	7.8	2.87	2.29	"	8.81	— .32	8.49	— .03	P.	+ 2.06	— .08
7	4284	Oct. 15	9.0	2.13	1.64	"	9.46	— .32	9.14	+ .62	S.	+ .87	— 1.21
8	4303	Oct. 16	7.5	4.28	3.16	"	7.94	— .32	7.62	— .90	U.	+ 2.23	+ .15
9	4304	" "	7.6	3.07	2.44	"	8.66	— .32	8.34	— .18	P.	+ 1.88	— .20
10	4366	Oct. 20	8.6	2.63	2.10	"	9.00	— .30	8.70	+ .18	S.	+ 1.00	— 1.00
11	4367	" "	8.6	3.08	2.44	"	8.66	— .30	8.36	— .16	P.	+ 1.40	— .60
12	4374	Oct. 21	7.1	2.26	1.77	"	9.33	— .30	9.03	+ .51	S.	+ .45	— 1.55
13	4375	" "	7.3	3.39	2.65	"	8.45	— .30	8.15	— .37	U.	+ 2.01	+ .01
14	4382	" "	8.4	3.80	2.90	"	8.20	— .30	7.90	— .62	P.	+ 1.68	— .32
15	4394	Oct. 22	6.1	3.36	2.63	"	8.47	— .30	8.17	— .35	P.	+ 1.74	— .24
16	4395	" "	6.2	2.65	2.12	"	8.98	— .30	8.68	+ .16	S.	+ 1.13	— .85
17	4445	Oct. 29	9.7	5.11	3.54	"	7.56	— .27	7.29	— 1.23	S.	+ 2.52	+ .56
18	4457	Nov. 2	7.8	2.90	2.31	"	8.79	— .26	8.53	+ .01	P.	+ 1.67	— .29
19	4612	Nov. 24	7.3	3.42	2.67	"	8.43	— .18	8.25	— .27	P.	+ 2.65	+ .22
20	4765	Dec. 26	7.0	3.35	2.62	"	8.48	— .08	8.40	— .12	P.	+ 2.30	— .13
21	4766	" "	7.1	3.60	2.78	"	8.32	— .08	8.24	— .28	U.	+ 2.46	+ .03
										8.52	± .43		
STAR <i>b.</i> (1877–79.)													
1	4146	Oct. 2	8.6	.67	9.13	11.10	11.97	— .35	11.62	+ .18	S.	+ .02	+ .23
2	4147	" "	8.6	.60	8.89	"	12.21	— .35	11.86	+ .42	P.	— .54	— .33
3	4171	Oct. 4	10.1	.63	9.00	"	12.10	— .35	11.75	+ .31	P.	— .28	+ .08
4	4172	" "	10.1	.58	8.82	"	12.28	— .35	11.93	+ .49	S.	— .56	— .20
5	4189	Oct. 6	8.0	.63	9.00	"	12.10	— .34	11.76	+ .32	P.	— .09	+ .40
6	4193	" "	8.6	.59	8.85	"	12.25	— .34	11.91	+ .47	S.	— .05	+ .44
7	4228	Oct. 10	8.6	.65	9.06	"	12.04	— .33	11.71	+ .27	P.	— .36	+ .25
8	4229	" "	8.7	.57	8.78	"	12.32	— .33	11.99	+ .55	U.	— 1.42	— .81
9	4232	" "	10.0	.44	8.22	"	12.88	— .33	12.55	+ 1.11	S.	— 1.42	— .81
10	4246	Oct. 13	6.8	.60	8.89	"	12.21	— .33	11.88	+ .44	S.	— 1.35	— .57
11	4249	" "	7.7	.70	9.23	"	11.87	— .33	11.54	+ .10	P.	— .99	— .21
12	4254	Oct. 14	7.0	.80	9.52	"	11.58	— .32	11.26	— .18	U.	— .60	+ .18
13	4260	" "	7.8	.70	9.23	"	11.87	— .32	11.55	+ .11	P.	— 1.19	— .41
14	4263	" "	8.6	.90	9.77	"	11.33	— .32	11.01	— .43	S.	— .48	+ .30
15	4285	Oct. 15	9.0	.99	9.98	"	11.12	— .32	10.80	— .64	S.	— .79	+ .05
16	4286	" "	9.1	.90	9.77	"	11.33	— .32	11.01	— .43	P.	— .90	— .06
17	4288	" "	9.3	.73	9.32	"	11.78	— .32	11.46	+ .02	U.	— .65	+ .19
18	4302	Oct. 16	7.3	1.11	.23	"	10.87	— .32	10.55	— .89	U.	— .70	+ .14
19	4305	" "	7.6	1.18	.36	"	10.74	— .32	10.42	— 1.02	P.	— .20	+ .64
20	4321	Oct. 17	7.5	.91	9.80	"	11.30	— .31	10.99	— .45	U.	— .62	+ .26
21	4322	" "	7.5	1.01	.02	"	11.08	— .31	10.77	— .67	P.	— 1.26	— .38
22	4398	Oct. 22	6.6	1.01	.02	"	11.08	— .30	10.78	— .66	U.	— .86	+ .08
23	4421	Oct. 26	7.5	1.16	.32	"	10.78	— .29	10.49	— .95	P.	— .38	+ .58
24	4433	Oct. 28	10.7	.84	9.62	"	11.48	— .28	11.20	— .24	P.	— .96	.00

No.	No. in Table I.	Date.	Hour.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring and Dist.	Corr. Diff. in Magn.	Resid.	Obs.	Iapetus - Star.	Resid.
STAR <i>b</i> (continued).													
25	4437	Oct. 29	7.8	.93	9.84	11.10	11.26	-.27	10.99	-.45	U.	-1.04	-.08
26	4440	" "	8.2	.92	9.82	"	11.28	-.27	11.01	-.43	P.	-1.18	-.22
27	4450	Nov. 1	7.2	.82	9.57	"	11.53	-.26	11.27	-.17	S.	-.70	+.27
28	4451	" "	7.2	.73	9.32	"	11.78	-.26	11.52	+.08	P.	-.98	-.01
29	4454	" "	7.5	.73	9.32	"	11.78	-.26	11.52	+.08	U.	-1.23	-.26
30	4456	Nov. 2	7.8	.84	9.62	"	11.48	-.26	11.22	-.22	P.	-1.02	-.06
31	4468	Nov. 3	6.0	.66	9.10	"	12.00	-.26	11.74	+.30	P.	-1.43	+.47
32	4469	" "	6.1	.71	9.26	"	11.84	-.26	11.58	+.14	S.	-.05	+.91
33	4472	Nov. 4	7.9	.59	8.85	"	12.25	-.26	11.99	+.55	P.	-1.56	-.60
34	4473	" "	7.9	.66	9.10	"	12.00	-.26	11.74	+.30	U.	-1.10	-.14
35	4476	" "	9.6	.68	9.16	"	11.94	-.26	11.68	+.24	S.	-1.02	-.06
36	4490	Nov. 5	9.4	3.54	2.74	14.00	11.26	-.25	11.01	-.43	P.		
37	4491	" "	9.5	3.22	2.54	"	11.46	-.25	11.21	-.23	U.		
38	4492	" "	9.6	3.35	2.62	"	11.38	-.25	11.13	-.31	S.		
39	4532	Nov. 8	6.5	.79	9.49	11.10	11.61	-.24	11.37	-.07	S.	-.94	.00
40	4535	" "	6.8	.94	9.87	"	11.23	-.24	10.99	-.45	P.	-.81	+.13
41	4536	" "	7.3	.72	9.29	"	11.81	-.24	11.57	+.13	U.	-.75	+.19
42	4539	Nov. 10	5.9	.97	9.93	"	11.17	-.23	10.94	-.50	P.	-.75	+.17
43	4540	" "	6.0	.89	9.75	"	11.35	-.23	11.12	-.32	S.	-.84	+.08
44	4549	Nov. 12	7.7	.94	9.87	"	11.23	-.22	11.01	-.43	P.	-.93	-.05
45	4550	" "	7.8	.75	9.38	"	11.72	-.22	11.50	+.06	U.	-1.22	-.34
46	4556	Nov. 13	6.8	1.29	.55	"	10.55	-.22	10.33	-1.11	S.	-.15	+.73
47	4558	" "	7.1	.92	9.82	"	11.28	-.22	11.06	-.38	U.	-1.04	-.16
48	4571	Nov. 14	6.6	.68	9.16	"	11.94	-.21	11.73	+.29	P.	-1.43	-.55
49	4574	" "	6.9	1.10	.21	"	10.89	-.21	10.68	-.76	S.	-.25	+.63
50	4575	" "	7.1	.92	9.82	"	11.28	-.21	11.07	-.37	U.	-1.05	-.17
51	4581	Nov. 15	6.7	5.17	3.57	14.00	10.43	-.21	10.22	-1.22	S.		
52	4582	" "	6.9	4.09	3.06	"	10.94	-.21	10.73	-.71	U.		
53	4583	" "	7.0	3.85	2.93	"	11.07	-.21	10.86	-.58	P.		
54	4585	" "	7.2	.87	9.70	11.10	11.40	-.21	11.19	-.25	P.	-.71	+.13
55	4589	" "	7.5	.72	9.29	"	11.81	-.21	11.60	+.16	U.	-1.02	-.18
56	4591	Nov. 16	7.9	.95	9.89	"	11.21	-.21	11.00	-.44	P.	-.68	+.16
57	4593	" "	8.4	1.21	.41	"	10.69	-.21	10.48	-.96	S.	-.21	+.63
58	4596	Nov. 23	8.1	.93	9.84	"	11.26	-.18	11.08	-.36	P.	-.33	+.16
59	4602	" "	8.9	.99	9.98	"	11.12	-.18	10.94	-.50	S.	+.18	+.67
60	4611	Nov. 24	7.3	.88	9.72	"	11.38	-.18	11.20	-.24	P.	-.30	+.19
61	4624	Nov. 26	6.9	.90	9.77	"	11.33	-.17	11.16	-.28	U.	-.51	-.15
62	4625	" "	7.0	.76	9.40	"	11.70	-.17	11.53	+.09	P.	-.02	+.34
63	4628	Nov. 29	5.7	.66	9.10	"	12.00	-.16	11.84	+.40	P.	.00	+.21
64	4630	" "	8.8	1.10	.21	"	10.89	-.16	10.73	-.71	S.	+.58	+.79
65	4633	Nov. 30	6.1	.67	9.13	"	11.97	-.16	11.81	+.37	S.	-.84	-.79
66	4634	" "	6.2	.79	9.49	"	11.61	-.16	11.45	+.01	P.	-.50	-.45
67	4642	Dec. 1	8.7	.94	9.87	"	11.23	-.16	11.07	-.37	P.	+.09	+.14
68	4643	" "	8.7	.76	9.40	"	11.70	-.16	11.54	+.10	S.	+.56	+.61
69	4645	Dec. 6	6.4	.78	9.46	"	11.64	-.14	11.50	+.06	S.	+.43	+.17
70	4646	" "	6.4	.92	9.82	"	11.28	-.14	11.14	-.30	P.	+.76	+.50
71	4649	" "	6.6	.70	9.23	"	11.87	-.14	11.73	+.29	U.	-.22	-.48
72	4660	Dec. 8	6.3	.67	9.13	"	11.97	-.13	11.84	+.40	P.	+.26	-.10
73	4661	" "	6.3	.79	9.49	"	11.61	-.13	11.48	+.04	S.	+.66	+.30
74	4664	Dec. 11	7.5	1.04	.08	"	11.02	-.13	10.89	-.55	U.	+.31	-.05
75	4666	Dec. 13	6.5	2.36	1.86	14.00	12.14	-.12	12.02	+.58	S.	-.05	-.31
76	4667	" "	6.7	3.10	2.46	"	11.54	-.12	11.42	-.02	U.	+.13	-.13
77	4670	" "	7.0	1.07	.15	11.10	10.95	-.12	10.83	-.61	S.	+.73	+.47
78	4671	" "	7.1	.86	9.67	"	11.43	-.12	11.31	-.13	U.	+.42	+.16
79	4673	Dec. 14	5.4	.96	9.91	"	11.19	-.12	11.07	-.37	P.	+.25	-.01
80	4676	" "	5.6	.86	9.67	"	11.43	-.12	11.31	-.13	S.	+.39	+.13

No.	No. in Table I.	Date.	Hour.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring and Dist.	Corr. Diff. in Magn.	Resid.	Obs.	Iapetus — Star.	Resid.
STAR <i>b</i> (continued).													
81	4677	Dec. 14	6.0	4.11	3.07	14.00	10.93	-.12	10.81	-.63	P.	+.88	+.62
82	4680	" "	6.1	3.40	2.66	"	11.34	-.12	11.22	-.22	S.	+.52	+.26
83	4682	Dec. 16	6.1	3.12	2.47	"	11.53	-.11	11.42	-.02	P.	-.11	-.23
84	4683	" "	6.2	4.61	3.32	"	10.68	-.11	10.57	-.87	S.	+.80	+.68
85	4685	" "	6.5	.73	9.32	11.10	11.78	-.11	11.67	+.23	P.	-.14	-.26
86	4688	" "	6.6	1.03	.06	"	11.04	-.11	10.93	-.51	S.	+.69	+.57
87	4690	" "	6.8	1.00	.00	"	11.10	-.11	10.99	-.45	U.	+.38	+.26
88	4692	" "	7.1	3.04	2.41	14.00	11.59	-.11	11.48	+.04	U.	+.58	+.46
89	4701	Dec. 17	9.4	.75	9.38	11.10	11.72	-.11	11.61	+.17	P.	-.34	-.46
90	4703	" "	9.6	.74	9.35	"	11.75	-.11	11.64	+.20	U.	-.11	-.23
91	4705	" "	9.7	4.32	3.18	14.00	10.82	-.11	10.71	-.73	P.	+.26	+.14
92	4707	" "	9.9	3.36	2.63	"	11.37	-.11	11.26	-.18	U.	+.11	-.01
93	4709	Dec. 18	5.9	2.91	2.32	"	11.68	-.10	11.58	+.14	P.	+.18	+.23
94	4711	" "	6.1	.62	8.96	11.10	12.14	-.10	12.04	+.60	P.	+.05	+.10
95	4717	" "	6.8	3.89	2.95	14.00	11.05	-.10	10.95	-.49	U.	+1.25	+1.30
96	4719	" "	8.4	.98	9.96	11.10	11.14	-.10	11.04	-.40	U.	+.16	+.21
97	4721	Dec. 19	7.1	.89	9.75	"	11.35	-.10	11.25	-.19	U.	-.16	-.11
98	4723	" "	7.4	3.14	2.48	14.00	11.52	-.10	11.42	-.02	U.	+.29	+.34
99	4724	" "	7.5	2.77	2.21	"	11.79	-.10	11.69	+.25	P.	-.18	-.13
100	4726	" "	7.7	.67	9.13	11.10	11.97	-.10	11.87	+.43	P.	-.08	-.03
101	4728	Dec. 20	7.7	2.78	2.22	14.00	11.78	-.09	11.69	+.25	P.	-.24	-.03
102	4731	" "	8.2	.80	9.52	11.10	11.58	-.09	11.49	+.05	P.	+.10	+.31
103	4733	Dec. 22	8.3	.68	9.16	"	11.94	-.09	11.85	+.41	P.	-.13	+.23
104	4735	Dec. 23	6.6	.69	9.19	"	11.91	-.08	11.83	+.39	P.	-.25	+.11
105	4736	" "	6.7	.88	9.72	"	11.38	-.08	11.30	-.14	U.	+.31	+.67
106	4739	" "	7.2	3.44	2.68	14.00	11.32	-.08	11.24	-.20	U.	.00	+.36
107	4740	" "	7.3	2.82	2.25	"	11.75	-.08	11.67	+.23	P.	-.54	-.18
108	4743	Dec. 24	7.1	.92	9.82	11.10	11.28	-.08	11.20	-.24	U.	-.06	+.43
109	4744	" "	7.2	.81	9.54	"	11.56	-.08	11.48	+.04	P.	-.79	-.30
110	4746	" "	7.3	2.86	2.28	14.00	11.72	-.08	11.64	+.20	P.	-.55	-.06
111	4749	" "	7.6	3.73	2.86	"	11.14	-.08	11.06	-.38	U.	+.26	+.75
112	4750	Dec. 25	6.0	4.04	3.03	"	10.97	-.08	10.89	-.55	P.	-.39	+.10
113	4753	" "	6.3	.70	9.23	11.10	11.87	-.08	11.79	+.35	P.	-.35	+.14
114	4754	" "	6.4	.93	9.84	"	11.26	-.08	11.18	-.26	U.	-.04	+.45
115	4757	" "	7.4	3.37	2.64	14.00	11.36	-.08	11.28	-.16	U.	-.25	+.24
116	4759	Dec. 26	6.3	3.35	2.62	"	11.38	-.08	11.30	-.14	P.	-.42	+.07
117	4760	" "	6.6	3.18	2.51	"	11.49	-.08	11.41	-.03	U.	-.52	-.03
118	4763	" "	6.9	.98	9.96	11.10	11.14	-.08	11.06	-.38	U.	-.55	-.06
119	4764	" "	7.0	.75	9.38	"	11.72	-.08	11.64	+.20	P.	-1.11	-.62
120	4769	Dec. 28	9.4	1.18	.36	"	10.74	-.07	10.67	-.77	P.	+.26	+.87
121	4771	Dec. 29	6.0	.83	9.60	"	11.50	-.07	11.43	-.01	P.	-.55	+.15
122	4773	Dec. 30	7.9	.69	9.19	"	11.91	-.07	11.84	+.40	U.	-.96	-.26
123	4774	" "	7.9	.86	9.67	"	11.43	-.07	11.36	-.08	P.	-.80	-.10
124	4777	" "	8.5	2.98	2.37	14.00	11.63	-.07	11.56	+.12	U.	-.65	+.05
125	4778	Dec. 31	5.9	.90	9.77	11.10	11.33	-.06	11.27	-.17	P.	-.53	+.25
126	4781	" "	6.8	.92	9.82	"	11.28	-.06	11.22	-.22	U.	-.64	+.14
127	4783	Jan. 3	6.1	.77	9.43	"	11.67	-.06	11.61	+.17	S.	-1.35	-.51
128	4784	" "	6.1	.88	9.72	"	11.38	-.06	11.32	-.12	P.	-.76	+.08
129	4787	" "	6.5	3.44	2.68	14.00	11.32	-.06	11.26	-.18	S.	-.47	+.37
130	4789	Jan. 5	5.8	.86	9.67	11.10	11.43	-.06	11.37	-.07	P.	-.65	+.23
131	4790	" "	5.9	.81	9.54	"	11.56	-.06	11.50	+.06	S.	-.98	-.10
132	4792	" "	6.6	3.12	2.47	14.00	11.53	-.06	11.47	+.03	S.	-.28	+.60
133	4795	Jan. 6	7.3	2.73	2.18	"	11.82	-.05	11.77	+.33	S.	-.56	+.32
134	4797	" "	7.5	.66	9.10	11.10	12.00	-.05	11.95	+.51	S.	-1.31	-.43
135	4798	" "	7.5	.89	9.75	"	11.35	-.05	11.30	-.14	P.	-.64	+.24
136	4799	" "	7.5	.55	8.70	"	12.40	-.05	12.35	+.91	U.	-.78	+.10

No.	No. in Table I.	Date.	Hour.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring and Dist.	Corr. Diff. in Magn.	Resid.	Obs.	Iapetus — Star.	Resid.
STAR <i>b</i> (continued).													
137	4803	Jan. 7	6.0	1.16	.32	11.10	10.78	— .05	10.73	— .71	S.	— .84	+ .08
138	4804	" "	6.2	1.04	.08	"	11.02	— .05	10.97	— .47	P.	— 1.06	— .14
139	4807	" "	6.5	2.80	2.24	14.00	11.76	— .05	11.71	+ .27	S.	— 1.58	— .66
140	4809	" "	6.8	.80	9.52	11.10	11.58	— .05	11.53	+ .09	U.	— 1.31	— .39
141	4811	Jan. 10	5.8	.44	8.22	"	12.88	— .05	12.83	+ 1.39	S.	— 1.22	— .28
142	4812	" "	5.9	.69	9.19	"	11.91	— .05	11.86	+ .42	P.	— 1.02	— .08
143	4815	Jan. 12	6.5	.74	9.35	"	11.75	— .04	11.71	+ .27	P.	— .83	+ .12
144	4816	" "	6.6	.65	9.06	"	12.04	— .04	12.00	+ .56	S.	— 1.07	— .12
145	4819	" "	7.0	2.78	2.22	14.00	11.78	— .04	11.74	+ .30	S.	— .59	+ .36
146	4822	Jan. 13	7.6	1.15	.30	11.10	10.80	— .04	10.76	— .68	P.	— .61	+ .35
147	4823	" "	7.7	1.14	.28	"	10.82	— .04	10.78	— .66	U.	— 1.45	— .49
148	4825	" "	8.3	.94	9.87	"	11.23	— .04	11.19	— .25	S.	— 1.21	— .25
149	4827	Jan. 18	6.0	2.94	2.34	14.00	11.66	— .03	11.63	+ .19	S.	— .49	+ .48
150	4829	" "	6.4	1.23	.45	11.10	10.65	— .03	10.62	— .82	S.	— .16	+ .81
151	4830	" "	6.5	1.27	.52	"	10.58	— .03	10.55	— .89	P.	— .64	+ .33
152	4834	Jan. 19	6.0	.58	8.82	"	12.28	— .03	12.25	+ .81	S.	— 1.04	— .07
153	4835	" "	6.1	.77	9.43	"	11.67	— .03	11.64	+ .20	P.	— 1.34	— .37
154	4837	" "	6.4	2.27	1.78	14.00	12.22	— .03	12.19	+ .75	S.	— .83	+ .14
155	4840	Jan. 20	6.1	.55	8.70	11.10	12.40	— .03	12.37	+ .93	S.	— .96	.00
156	4841	" "	6.1	.79	9.49	"	11.61	— .03	11.58	+ .14	P.	— .81	+ .15
157	4843	Jan. 23	6.3	1.10	.21	"	10.89	— .03	10.86	— .58	P.	— 1.53	— .57
158	4844	" "	6.4	1.14	.28	"	10.82	— .03	10.79	— .65	S.	— .43	+ .53
159	4847	" "	6.9	.89	9.75	"	11.35	— .03	11.32	— .12	U.	— .84	+ .12
160	4851	Jan. 25	6.5	.81	9.54	"	11.56	— .02	11.54	+ .10	P.	— 1.12	— .17
161	4852	" "	6.6	.57	8.78	"	12.32	— .02	12.30	+ .86	S.	— .90	+ .05
162	4856	Jan. 26	6.2	.46	8.31	"	12.79	— .02	12.77	+ 1.33	S.	— 1.20	— .26
163	4857	" "	6.3	.69	9.19	"	11.91	— .02	11.89	+ .45	P.	— 1.26	— .32
164	4860	Jan. 29	6.4	.79	9.49	"	11.61	— .02	11.59	+ .15	S.	— .41	+ .51
165	4861	" "	6.5	.84	9.62	"	11.48	— .02	11.46	+ .02	P.	— .81	+ .11
166	4863	Jan. 30	6.2	.90	9.77	"	11.33	— .02	11.31	— .13	P.	— .57	+ .35
167	4864	" "	6.3	.79	9.49	"	11.61	— .02	11.59	+ .15	S.	— 1.11	— .19
168	4867	" "	6.7	.81	9.54	"	11.56	— .02	11.54	+ .10	U.	— 1.37	— .45
169	4869	Jan. 31	7.3	.96	9.91	"	11.19	— .02	11.17	— .27	S.	— .42	+ .46
170	4870	" "	7.4	.65	9.06	"	12.04	— .02	12.02	+ .58	U.	— 1.47	— .59
171	4873	" "	7.5	.92	9.82	"	11.28	— .02	11.26	— .18	P.	— .62	+ .26
172	4877	Feb. 4	6.2	.62	8.96	"	12.14	— .02	12.12	+ .68	P.	— 1.24	— .46
173	4878	" "	6.4	.68	9.16	"	11.94	— .02	11.92	+ .48	S.	— .85	— .07
174	4883	" "	7.1	.85	9.65	"	11.45	— .02	11.43	— .01	U.	— .88	— .10
175	4886	Feb. 7	6.6	.50	8.50	"	12.60	— .01	12.59	+ 1.15	S.	— 1.24	— .54
176	4887	" "	6.7	.80	9.52	"	11.58	— .01	11.57	+ .13	U.	— .53	+ .17
177	4889	" "	6.9	.80	9.52	"	11.58	— .01	11.57	+ .13	S.		
178	4890	" "	7.0	.71	9.26	"	11.84	— .01	11.83	+ .39	U.		
179	4891	" "	7.0	.80	9.52	"	11.58	— .01	11.57	+ .13	P.		
180	4892	" "	7.1	.57	8.78	"	12.32	— .01	12.31	+ .87	P.	— 1.44	— .74
181	4894	Feb. 8	6.9	.85	9.65	"	11.45	— .01	11.44	.00	P.	— 1.14	— .44
182	4897	Feb. 9	6.9	.57	8.78	"	12.32	— .02	12.30	+ .86	S.	— 1.12	— .51
183	4898	" "	7.0	.83	9.60	"	11.50	— .02	11.48	+ .04	P.	— .28	+ .33
184	4899	" "	7.0	1.09	.19	"	10.91	— .02	10.89	— .55	P.		
185	4900	" "	7.0	.99	9.98	"	11.12	— .02	11.10	— .34	P.		
186	4901	" "	7.1	1.01	.02	"	11.08	— .02	11.06	— .38	S.		
187	4902	" "	7.2	.89	9.75	"	11.35	— .02	11.33	— .11	S.		
188	4904	Feb. 10	6.6	.60	8.89	"	12.21	— .01	12.20	+ .76	P.		
189	4905	" "	6.6	.66	9.10	"	12.00	— .01	11.99	+ .55	P.	— .56	+ .05
190	4907	Feb. 12	6.9	.69	9.19	"	11.91	— .01	11.90	+ .46	S.	— .96	— .47
191	4908	" "	7.0	.85	9.65	"	11.45	— .01	11.44	.00	U.	— 1.37	— .88
192	4914	Feb. 14	6.7	.70	9.23	"	11.87	— .02	11.85	+ .41	S.	— .10	+ .26

No.	No. in Table I.	Date.	Hour.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Corr. for Ring and Dist.	Corr. Diff. in Magn.	Resid.	Obs.	Iapetus — Star.	Resid.
STAR <i>b</i> (continued).													
193	4915	Feb. 14	6.8	.82	9.57	11.10	11.53	— .02	11.51	+ .07	P.	— .44	— .08
194	4916	" "	6.8	.63	9.00	"	12.10	— .02	12.08	+ .64	P.	— .84	— .48
195	4917	" "	6.9	.40	8.01	"	13.09	— .02	13.07	+ 1.63	S.	— .67	— .31
196	4818	" "	6.9	.44	8.22	"	12.88	— .02	12.86	+ 1.42	S.		
197	4919	" "	7.0	.68	9.16	"	11.94	— .02	11.92	+ .48	U.	— .70	— .34
198	4920	" "	7.1	.66	9.10	"	12.00	— .02	11.98	+ .54	U.	— .61	— .25
199	4923	Feb. 15	6.5	.72	9.29	"	11.81	— .01	11.80	+ .36	P.	— .56	— .35
200	4924	" "	6.6	.49	8.45	"	12.65	— .01	12.64	+ 1.20	S.	— .28	— .07
										11.44	± .39		± .36

The variations in the light of Iapetus may be determined either from the comparisons with Saturn given in Table XLIX., or from those with star *b* given in Table L. The advantage of the second of these methods is that as both objects are measured under very similar conditions, the observations are differential, and many of the sources of systematic error are eliminated. On the other hand, as two sets are required for each determination, we should expect an increase in the errors which are purely accidental. The results deduced by the two methods are given in the two parts of Table LI. The observations were first arranged in groups, placing together those in which the longitudes lie between 345° and 15° , 15° and 45° , &c. The mean longitude of each group will therefore nearly equal the number given in the first column, 0° , 30° , &c. The next four columns give the number of sets contained in each group, the mean difference in magnitude, the residual of the latter from its mean value, and the number corresponding to this residual. This is found in the usual way for reducing magnitudes to numbers, by multiplying by -0.4 , and taking the anti-logarithm. In the next column these numbers are divided by their mean, and multiplied by 100. They then show the observed light of Iapetus in any part of its orbit, its mean light being taken equal to 100.

We must now determine the equation of the curve which shall represent the variation in light, and thus obtain a means of computing the change of the light of Iapetus in different portions of its orbit. The most common explanation of the cause of this phenomenon is, first, that Iapetus, like our moon, rotates upon its axis and revolves in its orbit in the same time; and, secondly, that one part of the satellite reflects less light than the other. The simplest case is that in which the axis is perpendicular to the line of sight, and one hemisphere is uniformly light and the other dark, the line of separation of the two passing through the poles. In this case, let L represent the light when Iapetus is at a point of its orbit at an angular distance v from that in which

half of the bright and dark hemispheres are visible. Let a represent the mean brightness, or that when $v = 0$, and let b' represent the amount of increase or diminution in light; the light reflected when the bright hemisphere is towards the observer will then equal $a + b'$, that received from the dark hemisphere will equal $a - b'$, and $L = a + b' \sin v$. If v is measured from any other point in the orbit, or if v is the longitude, and Iapetus does not have its average light at superior conjunction, we shall have $L = a + b \sin v + c \cos v$, in which b and c are constants depending on the brightness of the two hemispheres and the angular distance of the point of average light from the conjunction.

Another hypothesis assumes that the satellite is not spherical, so that in turning it presents a disk of varying size. The problem here becomes very complex on account of the varying reflection at different angles of incidence. In general, there would be two maxima and two minima in each revolution, and the variation would be approximately represented by the terms $d \sin 2v + e \cos 2v$. If both causes act, no serious error will be introduced by adding the terms, or writing $L = a + b \sin v + c \cos v + d \sin 2v + e \cos 2v$. This equation is also that which we might assume empirically as the probable form of periodic variation.

We may now determine by the method of least squares the most probable values of a , b , c , d , and e , either from the comparison with Saturn or from that with star b . Forming the twelve equations of condition, we find that if we give equal weights to each, the normal equations become extremely simple. Owing to the symmetrical form of the equations of condition, all the coefficients but one become zero in the normal equations, and the most probable values of a , b , c , d , and e , are thus deduced directly. This also shows that each coefficient is independent of all the others. Substituting the values derived from the comparisons with Saturn and with star b we obtain, —

$$\begin{aligned} L &= 100 - 54 \sin v - 7 \cos v + 3 \sin 2v - 1 \cos 2v, \\ L &= 100 - 48 \sin v + 6 \cos v + 1 \sin 2v + 16 \cos 2v. \end{aligned}$$

If curves are constructed with abscissas equal to the variations of light, it will be seen that the comparisons with star b give much more accordant results than those with Saturn. If, therefore, we give double weight to the second of the above equations we obtain $L = 100 - 50 \sin v + 2 \cos v + 2 \sin 2v + 10 \cos 2v$. The coefficients of $\cos v$ and $\sin 2v$ are so small compared with the differences of the two formulas that they may be neglected and the value $L = 100 - 50 \sin v + 10 \cos 2v$ adopted as representing the true variation in light.

The seventh column of Table LI. gives the light in each portion of the orbit computed by the above formula, assuming that its mean brightness equals 100. The eighth column gives the difference between the sixth and seventh columns, or the

observed *minus* the computed brightness. The next column gives the first differences of the eighth column, or each residual *minus* that following it. Since the variation is periodic, the reading corresponding to 0° is taken from that corresponding to 330° . The last three columns give the corresponding quantities expressed in magnitudes. The numbers in the seventh column are reduced to magnitudes and entered in column ten. In the first part of the column they are subtracted from 15.80, so that their mean shall be 10.89, like the observed mean given in column three. In the second part of the column, the computed magnitudes are subtracted from 4.40, so that their mean shall equal $-.51$. The residuals and differences are then found from these quantities, as in columns eight and nine.

TABLE LI.

VARIATION IN LIGHT OF IAPETUS.

Long.	No. of Sets.	Diff. in Magn.	Residuals.			Percentages.			Magnitudes.		
			Magn.	Number.	Per Ct.	Comp.	Resid.	Diff.	Comp.	Resid.	Diff.
COMPARISON WITH SATURN.											
° 0	20	11.07	+.18	.85	77	110	-33	-17	10.70	+.37	+.14
30	35	11.27	+.38	.70	64	80	-16	-6	11.04	+.23	+.01
60	22	11.74	+.85	.46	42	52	-10	-45	11.52	+.22	+.92
90	18	11.10	+.21	.82	75	40	+35	+37	11.80	-.70	-.71
120	36	11.53	+.64	.55	50	52	-2	+19	11.52	+.01	-.31
150	33	11.36	+.47	.65	59	80	-21	-16	11.04	+.32	+.28
180	15	10.74	-.15	1.15	105	110	-5	-30	10.70	+.04	+.25
210	33	10.31	-.58	1.71	155	130	+25	+8	10.52	-.21	-.07
240	15	10.31	-.58	1.71	155	138	+17	+25	10.45	-.14	-.19
270	25	10.49	-.40	1.45	132	140	-8	-10	10.44	+.05	+.08
300	21	10.42	-.47	1.54	140	138	+2	-14	10.45	-.03	+.12
330	30	10.37	-.52	1.61	146	130	+16	+49	10.52	-.15	-.52
	303	10.89	±.45	1.10	100	100	±16	±23	10.89	±.21	±.30
COMPARISON WITH STAR <i>b</i> .											
° 0	10	- .93	-.42	1.47	134	110	+24	+21	-.70	-.23	-.18
30	17	- .41	+.10	.91	83	80	+3	0	-.36	-.05	+.03
60	7	+ .04	+.55	.60	55	52	+3	+4	+.12	-.08	-.09
90	3	+ .41	+.92	.43	39	40	-1	+6	+.40	+.01	-.13
120	26	+ .26	+.77	.49	45	52	-7	-1	+.12	+.14	+.06
150	25	- .28	+.23	.81	74	80	-6	-13	-.36	+.08	+.16
180	15	- .78	-.27	1.28	117	110	+7	+13	-.70	-.08	-.12
210	21	- .84	-.33	1.36	124	130	-6	-1	-.88	+.04	+.01
240	10	- .92	-.41	1.46	133	138	-5	+8	-.95	+.03	-.06
270	17	- .87	-.36	1.39	127	140	-13	-24	-.96	+.09	+.18
300	13	-1.04	-.53	1.63	149	138	+11	+21	-.95	-.09	-.16
330	21	- .81	-.30	1.32	120	130	-10	-34	-.88	+.07	+.30
	185	- .51	±.43	1.10	100	100	±8	±12	-.51	±.08	±.12

The accordance of the computed and observed variations in light may be tested by means of the above residuals. If all systematic error is eliminated, the residuals will follow the laws of accidental errors. As the order of the positive and negative residuals would then be determined by chance, the number of changes of sign should equal about one-half the number of residuals. If much less than one-half, the positive residuals must accumulate in one part of the orbit and the negative in another, or the computed values differ systematically from the observations. On the other hand, if the number of changes of sign is too great, it shows that the curve has been made to follow the observations too closely. That is, the computed curve has been made to follow sinuosities in the observed curve really due to errors of observations. By assuming a sufficient number of arbitrary constants, a curve could be computed which should agree almost exactly with the observations, and yet might not represent the true variation as well as a simpler curve which would eliminate a great portion of the accidental errors. Each group of twelve residuals happens to give six changes of sign, or exactly the correct number.

A severer test is afforded in the first differences of the residuals. If these are arranged according to accident, the difference of any two should, on the average, equal their mean value multiplied by the square root of two. The mean of the numbers in the ninth and twelfth columns should therefore equal those of the columns preceding them multiplied by the square root of two. This condition is fulfilled almost exactly in each portion of the Table. Both of these tests show that there is no perceptible systematic difference between the observed and computed values, and that a formula has been adopted containing as many arbitrary constants as the observations would justify.

The absence of the term $c \cos v$ shows that if the variation in light is due to unequal brightness of the two hemispheres of Iapetus, one half of each will always be turned towards Saturn. In other words, it would present to an observer at the north pole of Saturn the appearance of a half moon, the semicircle to the right being about four times as bright as that to the left.

Some doubt is thrown on the term $e \cos 2v$, since the comparisons with Saturn do not confirm its presence. Since the value of e is positive, it cannot be supposed to indicate that Iapetus is elongated in the direction of Saturn, although a slight elongation of this kind is probably implied in the assumption that the satellite turns once on its axis during each of its revolutions. An elongation sufficient to produce this effect might be caused by the attraction of Saturn, but it would be far too small to be perceptible photometrically. To make $e = +10$ the equatorial diameter of the satellite turned towards Saturn should be exceeded by that at right angles to it in the ratio of 9 to 11; so great a difference does not seem probable. The term $e \cos 2v$ could

also be accounted for by two bright or dark spots on the satellite. A dark spot on one side covering less than a hemisphere would also give a variation in light closely resembling that given by the formula. The most natural explanation, however, is that the dark and light portions are irregularly distributed on Iapetus, like the land and water on our Earth, and that one hemisphere is, on the whole, much darker than the other. The smaller variations may be assumed to be such that the formula given above represents them closely.

Equal weight is here given to the mean of the observations of each group. The residuals given to Table XLIX. could be somewhat reduced by adopting a formula found by giving to each group a weight proportional to the number of sets of which it was composed. A still further reduction might be made by assuming that the error in magnitudes was independent of the brightness. Evidently the absolute light would then be determined with much greater precision when Iapetus was faint. The weight would be equal to the square of the differential coefficient of the magnitude in terms of the light. As this coefficient will be inversely proportional to the light, the weight would become proportional to the number of sets divided by the square of the light. This would assign to the different sets a very different effect on the mean, as each of the observations at the preceding elongation would have about one-twelfth of the weight of one of those at the following elongation, so that we should make twelve times as many of the former as of the latter. As the observations were not planned in this way, it appears to be a little safer to give equal weights to each group.

The measurements show that the total change in the light of Iapetus is much less than is commonly supposed. This is probably due to two or three causes. The difference of a magnitude in the scale in common use for very faint stars corresponds to a much smaller change in light than that used for bright stars on which it is intended to be based. It has been shown, page 185, that even the scale of Struve increases more rapidly than the logarithmic scale of Pogson. Accordingly the difference in magnitudes between the maximum and minimum light would be estimated as a greater quantity than that given in the Table. Iapetus at its maximum can be seen with a smaller telescope than Rhea. The light of the latter is, however, apparently greatly diminished by the proximity of Saturn.

In Table LII. a comparison is made of the measurements of the satellites of Saturn. The consecutive columns give a current number, the name, the number of sets, the mean difference in magnitude as given in Table XLIX., this difference expressed in logarithms, the light of the ball of Saturn being taken as unity, and the ratio of the light of the ball to that of the satellite. The next two columns give the average deviations in magnitude of the separate sets, and the probable error of the mean, assuming that there is no systematic error. The last five columns give various expressions for

the diameter of the satellite on the supposition that its albedo equals that of Saturn. Each is followed by an expression for the probable error reduced to the same unit. The units adopted are, as in Table XLIII., the diameter of the planet, the second of arc seen from the mean distance of the planet and from a distance equal to that of the satellite from the centre of the planet, the kilometre, and the mile. The solar parallax is assumed as before to be $8''.80$, and the equatorial semidiameter of the Earth 6377 kilometres, or 3963 miles. From the data of the Nautical Almanac, the mean diameter of Saturn at the distance unity has the value $156''.18$, which is adopted in the computation. The corresponding numbers of kilometres and of miles are respectively 113176 and 70334. Since the equivalent diameters are measures of light and not of actual distances, two additional lines have been added corresponding to the maximum and minimum brightness of Iapetus.

TABLE LII.

DIMENSIONS OF SATELLITES OF SATURN DERIVED FROM PHOTOMETRIC OBSERVATIONS.

No.	Name.	No. of Sets.	Mean Diff. in Magn.	Log.	Ratio.	Av. Dev.	Prob. Error.	Equivalent Diameter.				
								In Diam. of Saturn.	Angle at Mean Dist.	Angle at Centre of Planet.	In Kilometres.	In Miles.
1	Mimas .	18	11.91	5.236	58080	.33	.07	$.0042 \pm .0001$	$.068 \pm .002$	522 ± 17	470 ± 15	292 ± 9
2	Enceladus	13	11.40	5.440	36310	.24	.06	$.0052 \pm .0001$	$.086 \pm .002$	515 ± 14	594 ± 16	370 ± 10
3	Tethys .	24	10.46	5.816	15280	.38	.07	$.0081 \pm .0003$	$.132 \pm .004$	640 ± 21	916 ± 30	570 ± 18
4	Dione .	17	10.57	5.772	16900	.32	.07	$.0077 \pm .0002$	$.126 \pm .004$	475 ± 15	871 ± 28	542 ± 17
5	Rhea .	16	9.88	6.048	8954	.36	.08	$.0106 \pm .0004$	$.173 \pm .006$	469 ± 17	1197 ± 44	745 ± 27
6	Titan .	18	8.50	6.600	2512	.38	.08	$.0200 \pm .0007$	$.327 \pm .012$	381 ± 14	2259 ± 83	1406 ± 52
7	Hyperion	45	12.81	4.876	133000	.47	.06	$.0027 \pm .0001$	$.045 \pm .001$	43 ± 1	310 ± 9	193 ± 5
8	Iap.(mean)	303	10.80	5.680	20890	.39	.02	$.0069 \pm .0001$	$.113 \pm .001$	45 ± 0	783 ± 7	486 ± 4
9	" (max.)		10.44	5.824	15000			.0082	.134	54	925	574
10	" (min.)		11.80	5.280	52480			.0044	.071	29	494	307

The mean difference in magnitude between Saturn and Iapetus adopted in Table LII. is that corresponding to the mean brightness of the satellite, and not to 10.89, the mean of the differences in magnitude given in Table LI. The latter value is not employed in Table LII., because the variation in the observed brightness of Iapetus is large and not referable to error of observation. Hence, undue weight would be given to measurements made when the satellite was faint, if the mean of the differences in magnitude was adopted as a measure of the mean difference in light. Accordingly, the required difference in magnitude is that corresponding to a light of 100 or 15.80 — $5.00 = 10.80$. Only the first part of Table LI. is used in finding this number, because a determination deduced from the second part would be, in fact, dependent upon the preceding one.

Except in the case of Iapetus, Table XLIX. exhibits no striking instance of a change in the light of any satellite depending upon its position in its orbit. But since the maxima and minima of the light of Iapetus coincide with its elongations, it seems worth while to inquire whether any of the other satellites appear to be brighter at one elongation than at the other. This, indeed, is the only way in which the possible variations of Mimas and of Enceladus can be exhibited, since these satellites could be observed only near their elongations. Accordingly, the results of the observations made on each satellite in the preceding and in the following halves of its orbit have been collected and compared. The quantities obtained by subtracting the mean difference of magnitude between Saturn and a preceding satellite from that between Saturn and the same satellite when following the planet are as follows: Mimas, $+0.52$; Enceladus, $+0.48$; Tethys, $+0.08$; Dione, -0.06 ; Rhea, -0.41 ; Titan, -0.15 ; Hyperion, $+0.06$. The computed difference between the elongations of Iapetus is $+1.36$, a much larger quantity than any of those just given. The error due to the position of the prism, noted on page 222, should give a positive value to all these differences were there no other cause of variation. The effect would be most marked with the five inner satellites, since in observing them Saturn was always covered by the prism, which was placed approximately in opposite positions at the preceding and following elongations. The variation in the signs seems to show that this source of error is nearly insensible. Of the seven satellites, only three give a difference large enough to suggest any cause but accident. In them the number of sets in the following half of the orbit is only six, three, and five, or is insufficient to determine the light with precision. It is possible that Mimas, like Iapetus, is brighter when preceding than when following Saturn; but the observations of the other satellites do not justify the inference that their light varies in different parts of their orbits.

In the years 1877 and 1878 the correction for the ring of Saturn was small, since the Earth was nearly in its plane. The observations should be repeated some years hence when the Earth is at its greatest distance from the plane of Saturn's equator. The correction for the ring will then attain its maximum value of nearly one magnitude. If the satellites are spherical their light will be unchanged, while as that of Saturn is increased, the observed difference in magnitude will be increased.

It is perfectly possible, although not probable, that one or more of the satellites may be surrounded by a ring like that of Saturn. In this case the same correction for ring should be applied both to satellite and planet, or their difference in magnitude should remain unchanged. A variation in the relative dimensions of the ball and ring of the satellite might give to this correction any assumed value. A decided flattening of the poles of the satellite would produce a similar effect.

CHAPTER X.

SATELLITES OF URANUS AND NEPTUNE.

THE light of the two outer satellites of Uranus was observed on nine evenings between February 3 and May 7, 1878. No observations were obtained of the inner satellites, owing to their extreme faintness, although on several evenings minute objects were detected in the immediate vicinity of Uranus. These afterwards proved to be stars, and as their brightness does not differ materially from that of the satellites, an examination of them at any future time will show to what extent the light of Uranus increases the difficulty of seeing the satellites.

All the measurements were made with Photometer I, and Uranus was always placed behind the prism in the eye-piece, that the effect of its light might be reduced. As *a Leonis* was distant less than three degrees, two sets were generally taken, Uranus being adopted as a standard in one, and *a Leonis* in the other. This was not always practicable, as the end of the telescope in some cases obstructed the view so that *a Leonis* could not be seen in the auxiliary telescope when the satellite was in the field and Uranus was behind the prism.

Table LIII. gives the measurements of Titania and Oberon. The columns give a current number, the number in Table I., the date, the hour, the object with which the comparison was made, and the longitude of the satellite. The individual readings are given in the next five columns; the faintness of the satellites renders them of interest, as showing the accordance of the measurements. They are followed by the mean reading, and five times its logarithm, or the difference in magnitude of the images in the large and small telescopes. The next column gives the difference in magnitude of the satellites and Uranus. Collecting from the preceding column all the corresponding sets in which the satellite was compared both with Uranus and *a Leonis*, we find from the twenty-two observations of Titania that Uranus is 3.79 magnitudes fainter than *a Leonis*, and from the fourteen observations of Oberon, a difference of 3.89 magnitudes. The mean of all the comparisons is accordingly 3.83, and this value is used in reducing the comparison with *a Leonis*. The two columns preceding the last in the Table give the average residuals of a single setting from the mean of the set, and of

TABLE LIII.

OBSERVATIONS OF TITANIA AND OBERON.

No.	No. in Table I.	Date.	Hour.	Standard of Comparison.	Longi- tude.	Single Readings.					Mean Read- ing.	Diff. in Magn. of Images.	Corr. Diff. in Magn.	Resid. one Setting.	Resid. one Set.	Obs.
						1.	2.	3.	4.	5.						
TITANIA. (1878.)																
1	1607	Feb. 3	9.7	α Leonis	120	.58	.47	.45	.46	.39	.47	8.36	8.91	.20	+.12	P.
2	1608	" "	9.8	Uranus	120	3.07	3.37	2.37	3.07	3.27	3.03	2.41	8.69	.19	-.10	P.
3	1689	Feb. 7	9.6	α Leonis	290	.56	.59	.60	.68	.75	.64	9.03	8.24	.22	-.55	P.
4	1690	" "	9.6	Uranus	290	3.58	4.27	3.70	3.30	4.15	3.80	2.90	8.20	.19	-.59	P.
5	1691	" "	9.7	"	290	2.95	3.54	3.91	2.98	3.14	3.30	2.59	8.51	.22	-.28	U.
6	1692	" "	9.8	α Leonis	290	.52	.56	.50	.50	.50	.52	8.58	8.69	.08	-.10	U.
7	1693	" "	10.0	"	290	.47	.54	.53	.55	.58	.53	8.62	8.65	.11	-.14	S.
8	1694	" "	10.1	Uranus	290	3.32	3.01	2.79	2.62	3.27	3.00	2.39	8.71	.17	-.08	S.
9	1997	Mar. 1	9.5	α Leonis	120	.38	.42	.49	.42	.45	.43	8.17	9.10	.15	+.31	U.
10	1998	" "	9.7	"	120	.33	.33	.49	.47	.38	.40	8.01	9.26	.35	+.47	S.
11	1999	" "	9.7	"	120	.60	.62	.42	.43	.48	.51	8.54	8.73	.34	-.06	P.
12	2000	" "	9.9	Uranus	120	2.67	2.83	3.28	2.78	2.27	2.77	2.21	8.89	.18	+.10	P.
13	2001	" "	10.0	"	120	2.00	2.03	1.82	2.02	2.11	2.00	1.50	9.60	.07	+.81	S.
14	2002	" "	10.2	"	120	2.90	2.86	2.55	2.38	2.63	2.66	2.12	8.98	.14	+.19	U.
15	2030	Mar. 5	8.0	Uranus	280	3.41	3.45	3.59	3.14	3.12	3.34	2.62	8.48	.11	-.31	P.
16	2031	" "	8.0	α Leonis	280	.73	.68	.61	.56	.61	.64	9.03	8.24	.18	-.55	P.
17	2032	" "	8.1	"	280	.47	.53	.43	.48	.36	.45	8.27	9.00	.20	+.21	U.
18	2033	" "	8.5	Uranus	280	2.62	2.78	2.59	2.79	2.61	2.68	2.14	8.96	.07	+.17	U.
19	2285	Mar. 22	9.1	Uranus	260	3.43	3.14	3.51	3.33	3.56	3.39	2.65	8.45	.08	-.34	P.
20	2286	" "	9.2	"	260	2.07	2.35	2.40	2.01	1.99	2.16	1.67	9.43	.17	+.64	U.
21	2287	" "	9.4	α Leonis	260	.63	.47	.48	.51	.59	.54	8.66	8.61	.24	-.18	P.
22	2288	" "	9.5	"	260	.41	.48	.44	.43	.50	.45	8.27	9.00	.14	+.21	U.
													8.79	.17	$\pm .30$	
OBERON. (1878.)																
1	1609	Feb. 3	9.9	α Leonis	270	.65	.51	.55	.52	.54	.55	8.70	8.57	.14	-.38	P.
2	1610	" "	10.0	Uranus	270	3.42	3.37	3.70	3.32	3.51	3.46	2.70	8.40	.07	-.55	P.
3	1628	Feb. 4	9.2	α Leonis	300	.55	.55	.49	.62	.48	.54	8.66	8.61	.17	-.34	P.
4	1629	" "	9.2	Uranus	300	3.94	3.07	2.90	3.29	3.43	3.33	2.61	8.49	.19	-.46	P.
5	1630	" "	9.5	α Leonis	300	.47	.40	.43	.45	.42	.43	8.17	9.10	.10	+.15	U.
6	1631	" "	9.6	Uranus	300	2.33	2.63	2.19	2.38	2.34	2.37	1.87	9.23	.10	+.28	U.
7	1632	" "	9.9	α Leonis	300	.46	.44	.45	.47	.39	.44	8.22	9.05	.11	+.10	S.
8	1633	" "	10.2	Uranus	300	2.22	2.42	2.31	2.60	2.48	2.45	1.95	9.15	.12	+.20	S.
9	2076	Mar. 8	9.3	Uranus	80	2.73	2.78	2.80	2.52	2.39	2.64	2.11	8.99	.12	+.04	P.
10	2077	" "	9.4	α Leonis	80	.43	.40	.37	.33	.40	.39	7.96	9.31	.16	+.36	P.
11	2078	" "	9.6	Uranus	80	2.49	2.90	2.32	2.48	2.69	2.58	2.06	9.04	.15	+.09	U.
12	2079	" "	9.6	α Leonis	80	.48	.41	.43	.40	.37	.42	8.12	9.15	.16	+.20	U.
13	2096	Mar. 9	9.0	α Leonis	100	.43	.47	.48	.48	.48	.47	8.36	8.91	.06	-.04	P.
14	2097	" "	9.1	Uranus	100	2.62	2.81	2.54	2.64	2.81	2.68	2.14	8.96	.08	+.01	P.
15	2282	Mar. 22	8.6	Uranus	90	3.67	4.00	3.59	3.37	2.92	3.51	2.73	8.37	.18	-.58	P.
16	2284	" "	8.9	"	90	3.13	3.36	3.09	3.49	3.71	3.36	2.63	8.47	.13	-.48	U.
17	2583	May 7	9.8	Uranus	240	2.02	2.11	2.12	2.28	2.14	2.13	1.64	9.46	.06	+.51	S.
18	2584	" "	10.0	"	240	1.77	2.01	2.00	1.76	1.91	1.89	1.38	9.72	.11	+.77	U.
19	2585	" "	10.2	"	240	2.71	2.45	2.41	2.54	2.53	2.53	2.02	9.08	.07	+.13	P.
													8.95	.12	$\pm .30$	

a single set from the mean of the whole. The first of these quantities is found by subtracting each setting from the mean of the set, and taking the mean of the differences without regard to their signs. This will equal the average deviation in divisions of the screw-head. To find the corresponding deviation in magnitudes we must differentiate the equation $M = C - 5 \log r$. This gives $dM = \frac{5 \times .434 dr}{r} = \frac{2.17}{r} dr$. Multiplying the average deviation found above by 2.17, and dividing by the mean reading of each set, gives the required quantity, which is entered in the column. The last column gives the initial of the observer.

In set No. 17 of the observations of Titania, the additional reading .46 was made and used in forming the mean, but omitted in the Table for want of space. A reading 2.65 is similarly omitted in set No. 8 of the observations of Oberon.

It has already been shown on page 163 that the errors of setting with Photometer H are small compared with the other sources of discrepancy. The difference is still more marked with Photometer I. Comparing the mean values of the average deviation of single settings of Titania and Oberon with the deviations of single sets, we find the latter nearly double the former. Since an error of one-half corresponds to a quadruple weight, and since each set in general contains five observations, it follows that the errors due to the inability of the eye to judge alike twice in succession constitute only one-twentieth of the whole. Accordingly, twenty errors equal to that of setting might be committed without exceeding the other errors of the measurement. Care must be taken to distinguish between consecutive settings and those taken by the same observer at different times, as the errors in the second case far exceed those in the first. No perceptible advantage would be gained by increasing the number of settings in each set. In fact, the above discussion shows that three settings in each set would give nearly as exact a result as five.

The star observed March 8, 1878, will have in 1880.0 the position R.A. = $9^h 56^m 18^s$, Dec. = $+13^\circ 24'.6$. Care should be taken not to mistake for it a much brighter star a little north of it and a few seconds following. Sets 2080 and 2081 make it 13.09 and 12.93 magnitudes fainter than α Leonis, or about a quarter of a magnitude fainter than Oberon. The star measured on March 22 will have in 1880.0 the position R.A. = $9^h 54^m 18^s$, and Dec. = $+13^\circ 34'.9$. The sets 2281 and 2283 assign to it a light of 8.72 and 8.99 magnitudes fainter than Uranus, or very nearly the brightness of Titania.

Similar measurements were made of the satellite of Neptune. All the comparisons were made with α Arietis, as Neptune was too faint an object for observation in the small telescope. To reduce the result we must have the light of Neptune in terms of that of α Arietis. This has accordingly been determined by eight sets of measurements given in the first part of Table LIV. These observations were made with the West Equatorial, and give the difference of magnitude 6.12. The measurements of

the satellite are given in the second portion of the Table, the columns having the same meaning throughout as in Table LIII.

TABLE LIV.

OBSERVATIONS OF NEPTUNE AND ITS SATELLITE.

No.	No. in Table I.	Date.	Hour.	Standard of Comparison.	Longi- tude.	Single Readings.					Mean Read- ing.	Diff. in Magn. of Images.	Corr. Diff. in Magn.	Resid. One Setting.	Resid. One Set.	Obs.
						1.	2.	3.	4.	5.						
NEPTUNE. (1878.)																
1	4435	Oct. 28	9.0	α Arietis		2.87	3.80	3.64	2.63	4.50	3.49	2.71	6.01	.37	— .11	P.
2	4436	" "	9.3	"		3.70	3.00	2.57	2.98	3.05	3.06	2.43	6.29	.18	+ .17	S.
3	4477	Nov. 4	8.8	"		3.12	2.91	2.30	4.33	3.10	3.15	2.49	6.23	.32	+ .11	P.
4	4478	" "	9.1	"		4.51	3.62	3.01	3.90	3.71	3.75	2.87	5.85	.21	— .27	S.
5	4479	" "	9.4	"		4.17	3.22	3.69	4.64	4.41	4.03	3.03	5.69	.25	— .43	U.
6	4693	Dec. 16	8.6	"		2.49	2.98	3.13	2.53	3.69	2.96	2.36	6.36	.27	+ .24	P.
7	4694	" "	8.7	"		3.81	2.58	2.37	3.25	3.91	3.18	2.51	6.21	.39	+ .09	S.
8	4695	" "	8.8	"		2.86	3.05	2.87	3.29	3.30	3.07	2.44	6.28	.12	+ .16	U.
													6.12	.26	$\pm$.20	
SATELLITE OF NEPTUNE. (1878.)																
1	4018	Sept. 23	10.1	α Arietis	270	.68	.58	.72	.78	.58	.67	9.13	5.85	.23	— .08	P.
2	4019	" "	10.3	"	280	.69	.72	.60	.70	.70	.68	9.16	5.82	.11	— .11	U.
3	4312	Oct. 16	10.1	"	240	1.11	1.29	1.21	1.23	1.20	1.21	.41	4.57	.08	— 1.36	P.
4	4422	Oct. 26	8.4	"	130	.65	.64	.56	.71	.63	.64	9.03	5.95	.11	+ .02	P.
5	4423	" "	8.8	"	130	.69	.59	.66	.60	.53	.61	8.93	6.05	.17	+ .12	S.
6	4429	Oct. 28	9.6	"	260	.53	.58	.62	.58	.62	.59	8.85	6.13	.10	+ .20	P.
7	4430	" "	9.8	"	260	.57	.53	.56	.51	.49	.53	8.62	6.36	.11	+ .43	S.
8	4431	" "	10.0	"	260	.48	.49	.56	.53	.50	.51	8.54	6.44	.11	+ .51	U.
9	4442	Oct. 29	8.6	"	310	.94	.79	.72	.63	.77	.77	9.43	5.55	.21	— .38	P.
10	4443	" "	8.8	"	310	.63	.64	.65	.56	.63	.62	8.96	6.02	.09	+ .09	U.
11	4501	Nov. 6	9.8	"	90	.58	.50	.55	.62	.55	.56	8.74	6.24	.12	+ .31	P.
12	4502	" "	10.0	"	90	.60	.58	.56	.51	.67	.58	8.82	6.16	.15	+ .23	S.
13	4503	" "	10.1	"	90	.58	.60	.57	.56	.58	.58	8.82	6.16	.03	+ .23	U.
14	4544	Nov. 12	7.2	"	90	.61	.60	.64	.61	.66	.62	8.96	6.02	.07	+ .09	P.
15	4545	" "	7.3	"	90	.62	.71	.60	.63	.50	.61	8.93	6.05	.18	+ .12	U.
16	4546	" "	7.4	"	90	.70	.69	.57	.67	.55	.64	9.03	5.95	.20	+ .02	U.
17	4547	" "	7.5	"	90	1.01	.86	.59	.71	.66	.77	9.43	5.55	.38	— .38	P.
													5.93	.14	$\pm$.28	

The discordance of set 3 of the observations of the satellite of Neptune is too large to ascribe to errors of observation. Since, however, no other reason can be assigned for its rejection, it has been retained. If omitted, the mean becomes 6.02, and the average deviation of a single set .18. It is possible that Neptune on October 16 was near a star which was mistaken for the satellite.

The dimensions of the outer satellites of Uranus and of the satellite of Neptune which result from these observations, on the assumption that the albedo of each planet

and that of its satellites are equal, are exhibited in Table LV. The computation is made in the same manner as before (pp. 237, 269), and with the same data for the solar parallax and the dimensions of the Earth. The diameter of Uranus is assumed to be $74''.50$ at distance unity, as in the British Nautical Almanac. The different determinations of the diameter of Neptune are too discordant to furnish a satisfactory result, as is shown by Kaiser in Vol. III. of the Leiden Observations. The value here employed, $76''.94$ at distance unity, is taken from Newcomb's Popular Astronomy, in which the semidiameter at the mean distance is given as $1''.28$. This value is somewhat greater than that employed by Zöllner, which is $36''.23$ for the semidiameter at distance unity (Photometrische Untersuchungen, p. 164). With the assumed values the diameters of Uranus and Neptune are respectively, in kilometres, 53860 and 55760; in miles, 33550 and 34650.

TABLE LV.

DIMENSIONS OF THE SATELLITES OF URANUS AND NEPTUNE, DERIVED FROM PHOTOMETRIC OBSERVATIONS.

No.	Name.	No. of Sets.	Mean Diff. in Magn.	Log.	Ratio.	Av. Dev.	Pr. Err.	Equivalent Diameter.				
								In Diam. of Planet.	Angle at Mean Dist.	Ang. at Cent. of Planet.	In Kilometres.	In Miles.
1	Titania	22	8.79	6.484	3281	.30	.06	$.0175 \pm .0005$	$.068 \pm .002$	444 ± 12	942 ± 26	586 ± 16
2	Oberon	19	8.95	6.420	3802	.30	.06	$.0162 \pm .0004$	$.063 \pm .002$	308 ± 9	875 ± 24	544 ± 15
3	Sat. Nept.	17	5.93	7.628	236	.28	.06	$.0652 \pm .0018$	$.167 \pm .005$	2110 ± 60	3630 ± 100	2260 ± 60

The large equivalent diameter of the satellite of Neptune is noteworthy. As it is a much more difficult object than the outer satellites of Uranus, so great an excess in its diameter was not anticipated. The principal causes of its apparent faintness are presumably its comparative proximity to its primary, and its great distance from the Sun.

No evidence is shown by the measurements of variations in the light of these satellites in different portions of their orbits. If the mean of all the measurements, when the satellite has a longitude between 180° and 360° , is subtracted from the mean of the measurements when it lies between 0° and 180° , we obtain for Titania a difference of $+.36$, for Oberon of $-.09$, and for the satellite of Neptune $+.17$. Rejecting set 3 of the satellite of Neptune gives a difference of $-.01$. Since nearly all the observations were made east of the meridian, the effect of the position of the prism, if perceptible at all, would be to make the satellites appear a little brighter at their preceding than at their following elongations. No indication of this effect is afforded by the results just stated.

The results obtained in this and in the three preceding chapters may be compared with each other, and reduced to a scale of stellar magnitudes in close agreement with those in common use, by the aid of the measurements of the planets by Zöllner. The comparison was made with α *Aurigæ*, which according to the measurements of Seidel and Wolff is about two magnitudes brighter than an average second magnitude star. Its light may therefore be taken as the zero of the common scale of magnitudes. A brighter object will have a negative magnitude; a fainter, a positive. According to Zöllner (*Photometrische Untersuchungen*, pp. 131, 137, 147, 152), the logarithm of the ratio of the light of the various planets to that of α *Aurigæ* will be for Mars 0.9016, for Jupiter 1.0082, for the ball of Saturn 9.6291, for Uranus 7.8176, for Neptune 6.8453. These values are all reduced to the distance of mean opposition, or that between the Earth and planet, when both are at their mean distances from the Sun and in line with it. Their magnitudes may therefore be expressed by the following numbers: Mars, -2.25 ; Jupiter, -2.52 ; Saturn, $.93$; Uranus, 5.46 ; Neptune, 7.89 . The last two numbers agree well with the measurements given in this chapter. Reducing the observed differences in magnitude between Uranus and α *Leonis*, and between Neptune and α *Arietis* to the mean oppositions of the planets, they become respectively 3.93 and 6.14 . With these values, and the magnitudes of Uranus and Neptune found above from Zöllner's observations, the resulting magnitudes of α *Leonis* and α *Arietis* become 1.53 and 1.75 , values which agree well with the usual estimates.

The magnitudes of the various satellites, obtained by adding the differences of magnitude adopted in Tables XLIII., XLVIII., LII., and LV. to the magnitudes just assigned to the planets, and arranged in the order of brightness, are as follows: Satellite III of Jupiter, 5.24 ; I, 5.61 ; II, 5.75 ; IV, 6.37 ; Titan, 9.43 ; Rhea, 10.81 ; Tethys, 11.39 ; Dione, 11.50 ; Iapetus, at its mean brightness, 11.82 ; Phobos, 12.31 ; Enceladus, 12.33 ; Deimos, 12.61 ; Mimas, 12.84 ; Hyperion, 13.74 ; Satellite of Neptune, 13.82 ; Titania, 14.25 ; Oberon, 14.41 . Mimas and the satellite of Neptune proved to be the most difficult of the objects observed, owing to the nearness of their primaries rather than from the faintness of the objects. Opinions differ as to the best powers to be used in detecting such objects. I understand that at the Pulkowa Observatory the lowest powers are preferred, and at the Washington Observatory the highest. We were unable to see the satellite of Neptune with a lower power than 400, while Mimas was best seen with a power of 140, which was that ordinarily used with Photometers D, E, and I.

CHAPTER XI.

UNEQUAL DOUBLE STARS.

THE following measurements relate to the brighter stars which have in their immediate vicinity very minute companions. A comparison is made of the light of the two components, which will furnish an observer with the means of reducing his scale of magnitudes to absolute measures. It should be remembered, however, that a proper allowance must be made for the proximity of the bright star, if these results are to be applied to estimating the magnitude of faint stars at a distance from any object bright enough to dazzle the eye.

The list of objects has been compiled from various sources. Most of the stars in Smyth's Cycle of Celestial Objects have been included, if the brighter component is above the magnitude $3\frac{1}{2}$, and the fainter below the magnitude 11. A valuable addition to this list was kindly furnished by Mr. Burnham of Chicago, who has supplied a list of the most difficult test objects of this kind with which he was acquainted. A large portion of these companions were discovered with the 26 inch telescope at Washington, or the 18 inch telescope at Chicago. It is, however, so much easier to detect an object when its position is known that but few of them proved too faint for satisfactory measurement with the 15 inch telescope of this Observatory. The more important objects were observed on at least three nights by two or three observers.

The measurements are given in Table LVI., which contains a current number, the number in Table I., the date, the mean reading, the corresponding difference in magnitude, the residual from the mean, and the initial of the observer. In deducing the magnitude from the mean reading, care must be taken to notice in Table I. which photometer was used, as otherwise a wrong constant might be applied.

No measurements of unequal double stars have been omitted from this Table, although when the smaller component is bright much reliance must not be placed on the result here given. This remark applies to most of the stars common to Tables IV. and LVI. The readings of such stars with Photometers E, G, and I are generally too small, or the difference in magnitude is too large. The images are seen with such different magnifying powers that a comparison is difficult. Better results are obtained with a reduced aperture, which makes the companion fainter.

TABLE LVI.

LEDGER OF UNEQUAL DOUBLE STARS.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
1. α ANDROMEDÆ. Σ 13 ^{II} . (1877-78.)							5. γ PEGASI c (continued).						
1	1213	Dec. 29	2.12	9.47	-.15	P.	5	1641	Feb. 5	1.45	10.29	+.69	P.
2	1214	" "	1.84	9.78	+.16	S.	6	1643	" "	.83	11.50	-.52	U.
3	1237	Jan. 3	2.14	9.45	-.17	P.					10.98	±.47	
4	1238	" "	1.80	9.32	-.30	S.	6. ι CETI. (1878.)						
5	1263	Jan. 5	2.14	9.45	-.17	P.	1	1529	Jan. 29	3.47	8.40	-.44	P.
6	1264	" "	1.57	10.22	+.60	S.	2	1530	" "	5.00	7.60	-1.24	S.
				9.62	±.26		3	1531	" "	4.02	8.08	-.76	U.
2. α ANDROMEDÆ. Σ 13 ^{II} . (1878.) Repeated.							4	1532	" "	2.91	8.78	-.06	S.
1	3581	Aug. 23	2.29	9.30	+.18	U.	5	1636	Feb. 5	2.29	9.30	+.46	P.
2	3582	" "	2.32	9.27	+.15	S.	6	1637	" "	2.87	8.81	-.03	S.
3	3599	Aug. 26	1.87	9.74	+.62	U.	7	1638	" "	2.96	8.74	-.10	U.
4	3764	Sept. 8	2.57	9.05	-.07	P.	8	1674	Feb. 7	2.30	9.29	+.45	P.
5	3790	Sept. 9	3.08	8.66	-.46	P.	9	1675	" "	1.81	9.81	+.97	S.
6	3791	" "	3.00	8.71	-.41	S.	10	1676	" "	2.05	9.54	+.70	U.
				9.12	±.32						8.84	±.52	
3. α ANDROMEDÆ Σ 13 ^{II} . (1878.) Aperture 12.7 cms.							7. δ ANDROMEDÆ B. (1877-78.)						
1	3598	Aug. 26	.64	9.69	+.90	U.	1	1198	Dec. 28	2.38	9.22	-.11	P.
2	3765	Sept. 8	.93	8.88	+.09	P.	2	1310	Jan. 12	2.42	9.18	-.15	P.
3	3792	Sept. 9	1.31	8.13	-.66	S.	3	1311	" "	1.58	10.11	+.78	S.
4	3793	" "	1.03	8.66	-.13	P.	4	1542	Jan. 29	3.13	8.62	-.71	S.
5	3859	Sept. 15	1.06	8.59	-.20	S.	5	1543	" "	2.09	9.50	+.17	S.
				8.79	±.40						9.33	±.38	
4. γ PEGASI B. (1878.)							8. δ ANDROMEDÆ c. (1878.)						
1	1305	Jan. 12	1.56	10.13	-.45	P.	1	1309	Jan. 12	1.89	9.72	+.33	P.
2	1307	" "	1.14	10.82	+.24	S.	2	1541	Jan. 29	2.20	9.39	.00	P.
3	1533	Jan. 29	1.93	10.67	+.09	P.	3	1625	Feb. 4	2.45	9.15	-.24	P.
4	1535	" "	1.42	10.34	-.24	U.	4	1626	" "	2.10	9.49	+.10	S.
5	1642	Feb. 5	2.02	10.95	+.37	P.	5	1627	" "	2.38	9.22	-.17	U.
6	1644	" "	1.24	10.57	-.01	U.					9.39	±.17	
				10.58	±.23		9. α CASSIOPEÆ. Σ Un. (1878.) Aperture 12.7 cms.						
5. γ PEGASI c. (1878.)							1	3766	Sept. 8	2.32	6.89	+.55	P.
1	1306	Jan. 12	1.21	10.69	-.29	P.	2	3794	Sept. 9	2.91	6.40	+.06	P.
2	1308	" "	.79	11.61	+.63	S.	3	3795	" "	3.83	5.80	-.54	S.
3	1534	Jan. 29	1.29	10.55	-.43	P.	4	3876	Sept. 16	3.25	6.16	-.18	S.
4	1536	" "	.94	11.23	+.25	U.	5	3877	" "	2.85	6.45	+.11	U.
											6.34	±.29	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
10. γ CASSIOPELÆ B. (1878.)							18. β ANDROMEDÆ E. (1878.)						
1	1657	Feb. 6	.98	11.14	+.04	S.	1	1316	Jan. 12	1.37	10.42		P.
2	1658	" "	.87	11.40	+.30	U.	19. β ANDROMEDÆ F. (1878.)						
3	1659	" "	.90	11.33	+.23	P.	1	1317	Jan. 12	.90	11.33		P.
4	1683	Feb. 7	1.34	10.46	-.64	S.	20. β ANDROMEDÆ G. (1878.)						
5	1684	" "	1.24	10.63	-.47	U.	1	1318	Jan. 12	1.29	10.55		P.
6	1685	" "	1.34	10.46	-.64	P.	21. θ CASSIOPELÆ B, α CASSIOPELÆ. (1879.)						
7	1940	Feb. 24	.89	11.35	+.25	S.	1	4996	Mar. 5	1.41	10.35	+.99	S.
8	1941	" "	1.03	11.04	-.06	P.	2	4999	" "	1.48	10.25	+.89	U.
9	1977	Feb. 27	.99	11.12	+.02	P.	3	5022	Mar. 10	1.77	9.86	+.50	U.
10	1978	" "	.80	11.58	+.48	U.	4	5023	" "	3.01	8.71	-.65	P.
11	1979	" "	.78	11.64	+.54	S.	5	5026	" "	2.25	9.34	-.02	U.
				11.10	$\pm .33$		6	5027	" "	2.66	8.98	-.38	P.
11. γ CASSIOPELÆ C. (1878.)							7	5028	Mar. 11	1.76	9.88	+.52	S.
1	1655	Feb. 6	.76	11.70		S.	8	5031	" "	2.97	8.73	-.63	P.
12. γ CASSIOPELÆ D. (1878.)							9	5035	Mar. 18	2.82	8.85	-.51	P.
1	1656	Feb. 6	.76	11.70		S.	10	5036	" "	3.17	8.60	-.76	U.
13. μ ANDROMEDÆ. (1877-78.)											9.36	$\pm .58$	
1	1199	Dec. 28	1.58	10.11	-.22	P.	22. θ CASSIOPELÆ C, α CASSIOPELÆ. (1879.)						
2	1244	Jan. 3	1.53	10.18	-.15	P.	1	4997	Mar. 5	1.11	10.87	+.83	S.
3	1245	" "	1.20	10.70	+.37	S.	2	4998	" "	1.08	10.94	+.90	U.
4	1246	" "	1.36	10.43	+.10	S.	3	5024	Mar. 10	1.97	9.63	-.41	U.
5	1312	Jan. 12	1.48	10.25	-.08	P.	4	5025	" "	2.39	9.21	-.83	P.
				10.33	$\pm .18$		5	5029	Mar. 11	1.56	10.13	+.09	S.
14. μ CASSIOPELÆ B, α CASSIOPELÆ. (1879.)							6	5030	" "	2.10	9.49	-.55	P.
1	5032	Mar. 18	2.39	9.21	-.17	P.					10.04	$\pm .60$	
2	5033	" "	2.05	9.54	+.16	U.	23. θ CASSIOPELÆ D, α CASSIOPELÆ. (1879.)						
				9.38	$\pm .16$		1	5034	Mar. 18	1.01	11.08	+.25	P.
15. β ANDROMEDÆ B. (1878.)							2	5037	" "	.80	11.58	-.25	U.
1	1313	Jan. 12	1.37	10.42		P.					11.33	$\pm .25$	
16. β ANDROMEDÆ C. (1878.)							24. α URSÆ MINORIS. Σ 93. (1878.)						
1	1314	Jan. 12	1.12	10.85		P.	1	3584	Aug. 23	4.03	8.07	+.22	S.
17. β ANDROMEDÆ D. (1878.)							2	3596	Aug. 26	4.28	7.94	+.09	U.
1	1315	Jan. 12	1.11	10.87		P.	3	3983	Sept. 22	4.18	7.99	+.14	P.
							4	3984	" "	4.37	7.90	+.05	S.
							5	3985	" "	5.19	7.52	-.33	S.
							6	4000	Sept. 23	4.87	7.66	-.19	P.
											7.85	$\pm .17$	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
25. α URSÆ MINORIS. Σ 93. (1878.) Aperture 12.7 cms.							30. α TAURI B. Σ 2 ^{II} . (1878.)						
1	1987	Feb. 28	1.27	8.20	+.90	U.	1	1686	Feb. 7	1.06	10.97	+.21	P.
2	1988	" "	1.61	7.69	+.39	P.	2	1687	" "	1.15	10.80	+.04	S.
3	3585	Aug. 23	3.02	6.32	-.98	S.	3	1688	" "	1.10	10.89	+.13	U.
4	3597	Aug. 26	2.00	7.22	-.08	U.	4	1938	Feb. 24	1.24	10.63	-.13	S.
5	3986	Sept. 22	2.42	6.80	-.50	S.	5	1939	" "	1.31	10.51	-.25	P.
6	3987	" "	1.88	7.35	+.05	P.					10.76	$\pm .15$	
7	4051	Sept. 27	1.74	7.52	+.22	P.							
				7.30	$\pm .45$		31. α TAURI C. (1878.)						
26. θ CETI. (1878.)							1	1605	Feb. 3	.65	12.06		P.
1	1537	Jan. 29	1.27	10.58	+.05	P.	32. σ^2 ORIONIS. (1878.)						
2	1538	" "	1.37	10.42	-.11	U.	1	1936	Feb. 24	2.32	[9.27]		P.
3	1623	Feb. 4	1.13	10.83	+.30	P.	2	1937	" "	2.92	[8.77]		S.
4	1624	" "	1.20	10.70	+.17	U.	3	1952	Feb. 26	2.13	9.46	+.21	P.
5	1639	Feb. 5	1.35	10.45	-.08	P.	4	1953	" "	1.88	9.73	+.48	S.
6	1640	" "	1.50	10.22	-.31	U.	5	2062	Mar. 8	2.65	8.98	-.27	P.
				10.53	$\pm .17$		6	2063	" "	2.85	8.83	-.42	U.
27. α ARIETIS. (1877-78.)											9.25	$\pm .34$	
1	1200	Dec. 28	1.62	10.05	-.16	P.	33. β ERIDANI. (1878.)						
2	3998	Sept. 22	1.50	10.22	+.01	P.	1	1930	Feb. 24	1.46	10.28	-.08	P.
3	3999	" "	1.46	10.37	+.16	S.	2	1931	" "	1.20	10.70	+.34	S.
4	4056	Sept. 27	1.44	10.31	+.10	S.	3	1942	Feb. 26	1.59	10.09	-.27	P.
5	4057	" "	1.58	10.11	-.10	U.	4	1943	" "	.99	11.12	+.76	S.
				10.21	$\pm .11$		5	1944	" "	1.52	10.19	-.17	U.
28. σ^2 40 ERIDANI C. (1878.)							6	2034	Mar. 5	1.43	10.32	-.04	P.
1	1594	Feb. 3	4.13	8.02	-.19	P.	7	2035	" "	1.83	9.79	-.57	U.
2	1596	" "	3.78	8.21	.00	S.					10.36	$\pm .32$	
3	1990	Mar. 1	3.59	8.32	+.11	P.	34. α AURIGÆ. (1878.)						
4	1992	" "	3.20	8.57	+.36	U.	1	4060	Sept. 27	1.10	10.89	+.11	P.
5	2087	Mar. 9	4.26	7.95	-.26	P.	2	4061	" "	1.01	11.08	+.30	U.
				8.21	$\pm .18$		3	4082	Sept. 28	1.29	10.55	-.23	P.
29. σ^2 40 ERIDANI D. (1878.)							4	4083	" "	.96	11.19	+.41	S.
1	1593	Feb. 3	2.66	8.98	-.20	P.	5	4110	Sept. 29	1.42	10.34	-.44	P.
2	1595	" "	2.55	9.07	-.11	S.	6	4111	" "	1.24	10.63	-.15	S.
3	1932	Feb. 24	2.55	9.07	-.11	P.					10.78	$\pm .27$	
4	1933	" "	2.01	9.58	+.40	S.	35. β ORIONIS C. (1878.)						
5	1989	Mar. 1	2.55	9.07	-.11	P.	1	1653	Feb. 6	.63	12.11	-.11	P.
6	1991	" "	2.30	9.29	+.11	U.	2	1654	" "	.42	12.98	+.76	S.
				9.18	$\pm .17$		3	1924	Feb. 24	.67	11.97	-.25	P.
							4	1925	" "	.76	11.70	-.52	S.
							5	1947	Feb. 26	.67	11.97	-.25	P.
							6	1948	" "	.50	12.60	+.38	U.
											12.22	$\pm .38$	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
36. β ORIONIS D. (1878.)							42. α CANIS MAJORIS C. (1878.)						
1	1945	Feb. 26	.33	13.51	+ .19	S.	1	1648	Feb. 5	.29	13.79	- .12	P.
2	1946	" "	.39	13.14	- .18	U.	2	1649	" "	.26	14.03	+ .12	S.
				13.32	$\pm .18$						13.91	$\pm .12$	
37. τ ORIONIS B. (1878.)							43. α CANIS MAJORIS D. (1878.)						
1	1928	Feb. 24	4.11	8.03	- .13	P.	1	1647	Feb. 5	.54	12.44	- .20	P.
2	1949	Feb. 26	3.73	8.24	+ .08	P.	2	1650	" "	.45	12.83	+ .19	S.
3	1994	Mar. 1	4.07	8.05	- .11	S.					12.64	$\pm .20$	
4	1995	" "	3.97	8.11	- .05	U.							
5	2036	Mar. 5	3.00	8.71	+ .55	P.							
6	2037	" "	4.53	7.82	- .34	U.							
				8.16	$\pm .21$								
38. τ ORIONIS CD. (1878.)							44. β CANIS MINORIS B. (1878.)						
1	1929	Feb. 24	2.65	8.98	- .22	P.	1	2577	May 7	1.46	10.28	+ .17	U.
2	1950	Feb. 26	2.57	9.05	- .15	P.	2	2582	" "	1.61	10.07	- .04	S.
3	1951	" "	2.11	9.48	+ .28	U.	3	2608	May 10	2.09	9.50	- .61	P.
4	1993	Mar. 1	1.80	9.82	+ .62	S.	4	2611	" "	1.27	10.58	+ .47	U.
5	1996	" "	2.72	8.93	- .27	U.					10.11	$\pm .32$	
6	2038	Mar. 5	2.32	9.27	+ .07	P.							
7	2039	" "	2.82	8.85	- .35	U.							
				9.20	$\pm .28$								
39. γ ORIONIS. (1878.)							45. β CANIS MINORIS C. (1878.)						
1	1934	Feb. 24	.69	11.91	- .44	P.	1	1962	Feb. 26	1.24	10.63	+ .29	P.
2	1935	" "	.52	12.52	+ .17	S.	2	1965	" "	1.41	10.35	+ .01	U.
3	1954	Feb. 26	.47	12.74	+ .39	S.	3	2578	May 7	1.38	10.40	+ .06	U.
4	1955	" "	.60	12.21	- .14	U.	4	2581	" "	1.56	10.13	- .21	S.
5	1956	" "	.57	12.32	- .03	P.	5	2612	May 10	1.20	10.70	+ .36	U.
6	2060	Mar. 8	.60	12.21	- .14	P.	6	2613	" "	1.78	9.85	- .49	P.
7	2061	" "	.51	12.56	+ .21	U.					10.34	$\pm .24$	
				12.35	$\pm .22$								
40. α ORIONIS. (1878.)							46. β CANIS MINORIS D. (1878.)						
1	2053	Mar. 8	1.05	10.99		P.	1	2579	May 7	1.39	10.38	- .14	U.
41. α CANIS MAJORIS B. (1878.)							2	2580	" "	1.20	10.70	+ .18	S.
1	1922	Feb. 24	.74	11.75	- .18	P.	3	2609	May 10	1.54	10.16	- .36	P.
2	1923	" "	.57	12.32	+ .39	S.	4	2610	" "	1.12	10.85	+ .33	U.
3	2019	Mar. 5	.75	11.72	- .21	P.					10.52	$\pm .25$	
4	2048	Mar. 6	.64	12.07	+ .14	U.							
5	2082	Mar. 9	.72	11.81	- .12	P.							
				11.93	$\pm .21$								
42. α CANIS MAJORIS C. (1878.)							47. β CANIS MINORIS E. (1878.)						
1	1960	Feb. 26	.55	12.40	+ .23	S.	1	1960	Feb. 26	.55	12.40	+ .23	S.
2	1961	" "	.61	12.17	.00	P.	2	1961	" "	.61	12.17	.00	P.
3	1963	" "	.68	11.94	- .23	U.	3	1963	" "	.68	11.94	- .23	U.
				12.17	$\pm .15$								
43. α CANIS MAJORIS D. (1878.)							48. β CANIS MINORIS F. (1878.)						
1	1964	Feb. 26	.59	12.25		U.	1	1964	Feb. 26	.59	12.25		U.

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
49. α GEMINORUM c. Σ 4 ^{II} . (1878.)							54. ϵ VIRGINIS. (1878.)						
1	2614	May 10	2.89	8.80	+ .13	P.	1	2617	May 10	.84	11.48	+ .36	U.
2	2667	May 18	3.94	8.12	— .55	P.	2	2618	" "	.90	11.33	+ .21	P.
3	2668	" "	3.43	8.42	— .25	S.	3	2998	June 24	1.09	10.91	— .21	P.
4	2746	May 27	2.85	8.83	+ .16	S.	4	2999	" "	.94	11.23	+ .11	S.
5	2747	" "	3.20	8.57	— .10	P.	5	3069	June 30	1.23	10.65	— .47	P.
6	2752	May 28	2.49	9.12	+ .45	U.	6	3070	" "	1.00	11.10	— .02	S.
7	2753	" "	2.87	8.81	+ .14	S.					11.12	$\pm$.23	
				8.67	$\pm$.25		55. α VIRGINIS. (1878.)						
50. α CANIS MINORIS. (1878.)							1	2876	June 14	.60	12.21	+ .53	P.
1	1957	Feb. 26	.75	11.72	— .05	P.	2	2877	" "	.47	12.74	+ 1.06	S.
2	1958	" "	.68	11.94	+ .17	U.	3	3315	July 19	.93	11.26	— .42	P.
3	1959	" "	.80	11.58	— .19	S.	4	3316	" "	.68	11.94	+ .26	S.
4	2575	May 7	.79	11.61	— .16	P.	5	3332	July 21	1.47	10.26	— 1.42	P.
5	2576	" "	.73	11.78	+ .01	U.					11.68	$\pm$.74	
6	2606	May 10	.68	11.94	+ .17	P.	56. α BOOTIS. (1878.)						
7	2607	" "	.72	11.81	+ .04	U.	1	3333	July 21	.61	12.17	+ .01	P.
				11.77	$\pm$.11		2	3359	July 24	.59	12.25	+ .09	P.
51. δ CANCRI. (1878.)							3	3360	" "	.52	12.52	+ .36	S.
1	2615	May 10	2.33	9.26	+ .09	P.	4	3375	Aug. 2	.67	11.97	— .19	P.
2	2616	" "	2.14	9.45	+ .28	U.	5	3376	" "	.69	11.91	— .25	S.
3	2827	June 9	2.92	8.77	— .40	P.					12.16	$\pm$.18	
4	2828	" "	2.41	9.19	+ .02	S.	57. ρ BOOTIS. (1878.)						
				9.17	$\pm$.20		1	3335	July 21	2.92	8.77	.00	P.
52. ι URSÆ MAJORIS. (1878.)							2	3361	July 24	2.62	9.01	+ .24	S.
1	2818	June 6	3.12	8.63	+ .29	P.	3	3362	" "	3.19	8.58	— .19	P.
2	2819	" "	3.48	8.39	+ .05	S.	4	3377	Aug. 2	3.70	8.26	— .51	P.
3	2829	June 9	3.99	8.10	— .24	P.	5	3378	" "	2.38	9.22	+ .45	S.
4	2830	" "	3.19	8.58	+ .24	S.					8.77	$\pm$.28	
5	2858	June 13	4.19	7.99	— .35	P.	58. α SERPENTIS. (1878.)						
				8.34	$\pm$.23		1	2874	June 14	1.90	9.71	+ .55	S.
53. δ LEONIS. (1878.)							2	2875	" "	2.95	8.75	— .41	U.
1	2801	June 5	1.27	10.58	+ .19	U.	3	3071	June 30	2.38	9.22	+ .06	S.
2	2802	" "	1.21	10.69	+ .30	S.	4	3072	" "	2.41	9.19	+ .03	P.
3	2825	June 9	1.42	10.34	— .05	P.	5	3317	July 19	2.73	8.92	— .24	S.
4	2826	" "	1.21	10.69	+ .30	S.					9.16	$\pm$.26	
5	2859	June 13	1.94	9.66	— .73	P.							
				10.39	$\pm$.31								

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
59. η HERCULIS B. (1878.)							65. α LYRÆ B. Σ 9 ^{II} . (1878.) Repeated.						
1	3574	Aug. 22	2.38	9.22	+ .49	S.	1	3583	Aug. 23	1.29	10.55	+ .02	S.
2	3575	" "	2.69	8.95	+ .22	U.	2	3602	Aug. 26	1.14	10.82	+ .29	U.
3	3923	Sept. 18	3.13	8.62	— .11	U.	3	3605	" "	1.01	11.08	+ .55	S.
4	3926	" "	3.21	8.57	— .16	P.	4	3903	Sept. 17	1.20	10.70	+ .17	P.
5	3939	Sept. 19	3.63	8.30	— .43	P.	5	3916	Sept. 18	1.57	10.12	— .41	P.
				8.73	$\pm$.28		6	3917	" "	1.66	10.00	— .53	U.
							7	3918	" "	1.34	10.46	— .07	S.
										10.53	$\pm$.29		
60. η HERCULIS C. (1878.)							66. α LYRÆ B. Σ 9 ^{II} . (1878.) Aperture 12.7 cms.						
1	3573	Aug. 22	1.04	11.02	+ .23	S.	1	3603	Aug. 26	.60	9.83	— .55	U.
2	3576	" "	.94	11.23	+ .44	U.	2	3604	" "	.36	10.94	+ .56	S.
3	3924	Sept. 18	1.14	10.82	+ .03	U.	3	3857	Sept. 15	.46	10.41	+ .03	P.
4	3925	" "	1.28	10.56	— .23	P.	4	3858	" "	.43	10.55	+ .17	S.
5	3938	Sept. 19	1.43	10.32	— .47	P.	5	3904	Sept. 17	.51	10.18	— .20	P.
				10.79	$\pm$.28					10.38	$\pm$.30		
61. μ SAGITTARI D. (1878.)							67. α LYRÆ C. (1878.)						
1	2980	June 23	5.26	7.50	— .53	P.	1	3606	Aug. 26	.93	11.26	— .15	S.
2	4001	Sept. 23	3.75	8.23	+ .20	U.	2	3607	" "	.81	11.56	+ .15	U.
3	4002	" "	3.95	8.12	+ .09	S.				11.41	$\pm$.15		
4	4052	Sept. 27	3.69	8.26	+ .23	U.							
5	4053	" "	4.14	8.02	— .01	P.							
				8.03	$\pm$.21								
62. 32 μ SAGITTARI E. (1878.)							68. ϵ LYRÆ E, α LYRÆ. (1877-78.)						
1	2981	June 23	2.39	9.21		P.	1	585	Nov. 13	4.07	10.45	— .40	P.
63. η SERPENTIS. Σ 8 ^{II} . (1878.)							2	588	" "	4.05	10.46	— .39	U.
1	3027	June 26	2.82	8.85	+ .89	P.	3	591	" "	5.11	9.96	— .89	S.
2	3056	June 29	3.67	8.28	+ .32	P.	4	833	Dec. 9	1.11	10.87	+ .02	P.
3	3057	" "	5.68	7.33	— .63	S.	5	836	" "	.79	[11.61]		P.
4	3322	July 19	5.26	7.49	— .47	S.	6	837	" "	.96	11.19	+ .34	P.
5	3323	" "	4.46	7.85	— .11	P.	7	1251	Jan. 5	1.09	10.91	+ .06	P.
				7.96	$\pm$.48		8	1254	" "	.62	12.14	+ 1.29	S.
										10.85	$\pm$.48		
64. α LYRÆ B. Σ 9 ^{II} . (1877-78.)							69. ϵ LYRÆ F, α LYRÆ. (1877-78.)						
1	583	Nov. 13	4.13	10.42	— .55	P.	1	586	Nov. 13	1.19	13.12	— .12	P.
2	584	" "	3.61	10.71	— .26	U.	2	589	" "	.92	13.68	+ .44	U.
3	838	Dec. 9	1.01	11.08	+ .11	P.	3	592	" "	2.29	11.70	— 1.54	S.
4	1224	Jan. 3	1.07	10.95	— .02	P.	4	835	Dec. 9	.31	13.64	+ .40	P.
5	1249	Jan. 5	1.04	11.01	+ .04	P.	5	1252	Jan. 5	.35	13.38	+ .14	P.
6	1250	" "	.77	11.67	+ .70	S.	6	1255	" "	.27	13.94	+ .70	S.
				10.97	$\pm$.28					13.24	$\pm$.56		

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
70. ϵ LYRÆ G, α LYRÆ. (1877-78.)						
1	587	Nov. 13	1.60	12.48	-.63	P.
2	590	" "	1.41	12.75	-.36	U.
3	593	" "	1.68	12.37	-.74	S.
4	834	Dec. 9	.26	14.02	+.91	P.
5	1253	Jan. 5	.37	13.26	+.15	P.
6	1256	" "	.29	13.79	+.68	S.
				13.11	±.58	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
75. α^2 CYGNI B, α and α^2 CYGNI. (1877-78.)						
1	755	Dec. 3	.42	10.08	+.56	P.
2	756	" "	.58	9.38	-.14	U.
3	841	Dec. 9	.57	9.42	-.10	P.
4	1235	Jan. 3	2.38	9.22	-.30	P.
5	1236	" "	2.10	9.49	-.03	S.
				9.52	±.23	

71. 110 HERCULIS. (1878.)						
1	3342	July 22	2.83	8.84	-.05	P.
2	3546	Aug. 18	2.92	8.77	-.12	P.
3	3547	" "	3.14	8.62	-.27	S.
4	3569	Aug. 22	2.25	9.34	+.45	S.
5	3570	" "	2.54	9.08	+.19	U.
6	3571	" "	2.79	8.87	-.02	S.
7	3572	" "	3.01	8.71	-.18	U.
				8.89	±.18	

76. β CAPRICORNI CD. (1877-78.)						
1	578	Nov. 13	3.98	10.50	+.13	P.
2	581	" "	3.90	10.54	+.17	S.
3	582	" "	2.97	11.14	+.77	U.
4	3936	Sept. 19	1.72	9.92	-.45	P.
5	3937	" "	1.68	9.97	-.40	U.
6	4040	Sept. 25	1.55	10.15	-.22	P.
7	4041	" "	1.38	10.40	+.03	S.
				10.37	±.31	

72. γ AQUILÆ B, α and γ AQUILÆ. (1877-78.)						
1	753	Dec. 3	1.51	10.20	+.38	P.
2	754	" "	1.55	10.15	+.33	U.
3	1226	Jan. 3	.94	9.63	-.19	P.
4	1227	" "	.66	10.40	+.58	S.
5	1275	Jan. 6	2.43	9.17	-.65	P.
6	3959	Sept. 20	2.31	9.28	-.54	P.
7	3960	" "	1.73	9.91	+.09	U.
				9.82	±.39	

73. α AQUILÆ. Σ 10 ^{II} . (1877-78.)						
1	752	Dec. 3	1.95	9.65	-.38	U.
2	1225	Jan. 3	1.37	10.42	+.39	P.
3	1274	Jan. 6	1.82	9.80	-.23	P.
4	1295	Jan. 12	.91	11.30	+1.27	S.
5	3957	Sept. 20	2.36	9.24	-.79	U.
6	3958	" "	2.59	9.03	-1.00	P.
7	3994	Sept. 22	1.43	10.32	+.29	S.
8	3995	" "	1.34	10.46	+.43	P.
				10.03	±.60	

74. β AQUILÆ B, α and β AQUILÆ. (1877-78.)						
1	832	Dec. 9	.77	9.07	-.13	P.
2	3992	Sept. 22	2.55	9.07	-.13	P.
3	3993	" "	2.44	9.16	-.04	S.
4	4008	Sept. 23	2.82	8.85	-.35	P.
5	4009	" "	1.77	9.86	+.66	U.
				9.20	±.26	

77. β DELPHINI B. Σ 2704. (1877-78.)						
1	595	Nov. 13	12.43	8.03	-.67	S.
2	598	" "	15.61	7.53	-1.17	U.
3	603	" "	14.64	7.67	-1.03	P.
4	1228	Jan. 3	2.53	9.08	+.38	P.
5	1230	" "	1.61	10.07	+1.37	S.
6	1296	Jan. 12	2.50	9.11	+.41	P.
7	1297	" "	2.15	9.44	+.74	S.
8	1338	Jan. 14	3.09	8.65	-.05	P.
				8.70	±.73	

78. β DELPHINI B. Σ 2704. (1878.) Aperture 12.7 cms.						
1	3940	Sept. 19	2.52	6.71	-.31	P.
2	3941	" "	2.34	6.87	-.15	S.
3	3963	Sept. 20	2.36	6.86	-.16	U.
4	3964	" "	2.11	7.10	+.08	S.
5	3989	Sept. 22	1.71	7.55	+.53	P.
				7.02	±.25	

79. β DELPHINI C. (1877-78.)						
1	594	Nov. 13	6.24	9.52	.00	S.
2	600	" "	5.74	9.71	+.19	U.
3	602	" "	6.08	9.58	+.06	P.
4	720	Dec. 1	2.43	9.17	-.35	P.
5	1229	Jan. 3	1.80	9.82	+.30	P.
6	1337	Jan. 14	2.26	9.33	-.19	P.
				9.52	±.18	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
80. α DELPHINI B. (1877-78.)							85. α CYGNI c. (1877-78.)						
1	706	Nov. 30	2.40	9.20	-.05	P.	1	843	Dec. 9	.40	13.09	+.60	P.
2	710	" "	2.29	9.30	+.05	U.	2	4086	Sept. 28	.69	11.91	-.58	P.
3	1257	Jan. 5	2.32	9.27	+.02	P.	3	4122	Sept. 30	.48	12.69	+.20	S.
4	1258	" "	2.26	9.33	+.08	S.	4	4123	" "	.51	12.56	+.07	P.
5	1276	Jan. 6	2.70	8.94	-.31	P.	5	4142	Oct. 1	.60	12.21	-.28	S.
6	1277	" "	2.13	9.46	+.21	S.					12.49	$\pm .35$	
				9.25	$\pm .12$		86. ε CYGNI B. (1877-78.)						
81. α DELPHINI c. (1877-78.)							1	844	Dec. 9	1.50	10.22	+.29	P.
1	707	Nov. 30	1.73	9.91	+.34	P.	2	1546	Jan. 30	1.55	10.15	+.22	P.
2	4012	Sept. 23	2.66	8.98	-.59	S.	3	1548	" "	1.85	9.76	-.17	S.
3	4013	" "	2.21	9.38	-.19	U.	4	4028	Sept. 25	1.69	9.96	+.03	U.
4	4036	Sept. 25	1.80	9.82	+.25	P.	5	4031	" "	2.01	9.58	-.35	S.
5	4037	" "	1.87	9.74	+.17	U.					9.93	$\pm .21$	
				9.57	$\pm .31$		87. ε CYGNI c. (1878.)						
82. α DELPHINI D. (1877-78.)							1	1547	Jan. 30	1.22	10.67	-.36	P.
1	708	Nov. 30	2.46	9.15	+.56	U.	2	4029	Sept. 25	.89	11.35	+.32	U.
2	4011	Sept. 23	2.80	8.86	+.27	S.	3	4030	" "	.94	11.23	+.20	S.
3	4014	" "	2.62	9.01	+.42	U.	4	4087	Sept. 28	.94	11.23	+.20	P.
4	4032	Sept. 25	4.30	7.93	-.66	U.	5	4117	Sept. 30	1.23	10.65	-.38	P.
5	4034	" "	4.21	7.98	-.61	P.					11.03	$\pm .29$	
				8.59	$\pm .50$		88. η CEPHEI B. (1878.)						
83. α DELPHINI E. (1877-78.)							1	1677	Feb. 7	2.08	9.51	-.11	P.
1	709	Nov. 30	1.28	10.56	+.30	P.	2	1680	" "	2.30	9.29	-.33	U.
2	4010	Sept. 23	1.46	10.28	+.02	S.	3	1971	Feb. 27	2.02	9.57	-.05	P.
3	4015	" "	1.44	10.31	+.05	U.	4	1974	" "	2.07	9.52	-.10	U.
4	4033	Sept. 25	1.45	10.29	+.03	U.	5	2065	Mar. 8	1.80	9.82	+.20	P.
5	4035	" "	1.79	9.84	-.42	P.	6	2066	" "	1.66	10.00	+.38	U.
				10.26	$\pm .16$						9.62	$\pm .20$	
84. α CYGNI B. (1877-78.)							89. η CEPHEI c. (1878.)						
1	732	Dec. 2	.83	11.50	-.04	P.	1	1678	Feb. 7	1.26	10.60	+.16	P.
2	734	" "	.84	11.48	-.06	S.	2	1679	" "	1.09	10.91	+.47	U.
3	842	Dec. 9	.81	11.56	+.02	P.	3	1972	Feb. 27	1.31	10.51	+.07	P.
4	1231	Jan. 3	.92	11.28	-.26	P.	4	1973	" "	1.00	11.10	+.66	U.
5	1232	" "	.80	11.58	+.04	S.	5	2064	Mar. 8	1.83	9.79	-.65	P.
6	1233	" "	.83	11.50	-.04	P.	6	2067	" "	1.88	9.73	-.71	U.
7	1234	" "	.69	11.91	+.37	S.					10.44	$\pm .45$	
				11.54	$\pm .12$								

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
90. γ EQUULEI. (1877-78.)							96. α PEGASI C. (1877.)						
1	721	Dec. 1	2.70	8.94	+ .56	P.	1	605	Nov. 13	7.88	9.02	-.06	P.
2	722	" "	5.02	7.60	-.78	S.	2	607	" "	7.44	9.14	+.06	S.
3	3990	Sept. 22	2.76	8.90	+.52	P.					9.08	$\pm .06$	
4	3991	" "	2.94	8.76	+.38	S.	97. α AQUARI. (1877-78.)						
5	4005	Sept. 23	4.75	7.72	-.66	U.	1	640	Nov. 17	4.81	10.09	+.39	P.
				8.38	$\pm .58$		2	641	" "	5.75	9.70	.00	S.
91. δ EQUULEI. Σ 2777. (1878.) Aperture 12.7 cms.							3	725	Dec. 1	2.01	9.58	-.12	P.
1	3942	Sept. 19	4.74	5.34	-.45	U.	4	726	" "	2.28	9.31	-.39	S.
2	3943	" "	4.39	5.51	-.28	S.	5	1298	Jan. 12	1.74	9.90	+.20	P.
3	3961	Sept. 20	2.93	6.39	+.60	P.	6	1299	" "	1.98	9.62	-.08	S.
4	3962	" "	4.09	5.66	-.13	U.					9.70	$\pm .20$	
5	3988	Sept. 22	3.44	6.04	+.25	P.	98. γ AQUARI. (1878.)						
				5.79	$\pm .34$		1	1300	Jan. 12	2.18	9.41	+.11	S.
92. β AQUARI. (1877-78.)							2	1340	Jan. 14	2.01	9.58	+.28	P.
1	638	Nov. 17	7.42	9.15	+.02	P.	3	1350	Jan. 16	2.49	9.12	-.18	P.
2	639	" "	7.28	9.19	+.06	S.	4	1351	" "	2.05	9.54	+.24	S.
3	1278	Jan. 6	2.46	9.15	+.02	P.	5	1373	Jan. 18	2.72	8.93	-.37	P.
4	1279	" "	2.27	9.32	+.19	S.	6	1374	" "	2.35	9.24	-.06	S.
5	1348	Jan. 16	2.48	9.13	.00	P.					9.30	$\pm .21$	
6	1349	" "	2.81	8.86	-.27	S.	99. ζ PEGASI B, α and ζ PEGASI. (1877-78.)						
				9.13	$\pm .09$		1	757	Dec. 3	.89	9.95	-.15	U.
93. ε PEGASI C. (1877-78.)							2	758	" "	.74	10.35	+.25	S.
1	723	Dec. 1	1.25	10.62	+.10	S.	3	1354	Jan. 16	1.97	9.63	-.47	P.
2	724	" "	1.35	10.45	-.07	P.	4	1355	" "	1.45	10.29	+.19	S.
3	736	Dec. 2	.99	11.12	+.60	S.	5	1410	Jan. 19	1.25	10.62	+.52	S.
4	737	" "	1.05	10.99	+.47	P.	6	1411	" "	1.87	9.74	-.36	P.
5	1339	Jan. 14	1.45	10.29	-.23	P.					10.10	$\pm .32$	
6	4006	Sept. 23	1.37	10.42	-.10	P.	100. ξ PEGASI B. (1878.)						
7	4007	" "	1.33	10.48	-.04	U.	1	1357	Jan. 16	2.17	9.42	+.36	P.
8	4084	Sept. 28	1.69	9.96	-.56	P.	2	1407	Jan. 19	2.07	9.52	+.46	P.
9	4085	" "	1.40	10.37	-.15	S.	3	1408	" "	2.00	9.60	+.54	S.
				10.52	$\pm .26$		4	4054	Sept. 27	3.55	8.35	-.71	U.
94. ε PEGASI D. (1877.)							5	4055	" "	3.43	8.42	-.64	S.
1	738	Dec. 2	.65	12.04		P.					9.06	$\pm .54$	
95. μ CYGNI C. (1877-78.)							101. ξ PEGASI C, α and ξ PEGASI. (1877-78.)						
1	952	Dec. 16	2.83	8.84	+.02	P.	1	739	Dec. 2	2.42	9.18	+.32	P.
2	953	" "	2.91	8.78	-.04	S.	2	759	Dec. 3	.73	9.18	+.32	S.
3	1215	Dec. 31	1.99	9.61	+.79	P.	3	760	" "	1.17	8.16	-.70	U.
4	1216	" "	1.45	[10.29]		S.	4	1356	Jan. 16	3.09	8.65	-.21	P.
5	1621	Feb. 4	3.35	8.48	-.34	P.	5	1406	Jan. 19	2.81	8.86	.00	P.
6	1622	" "	3.52	8.37	-.45	U.	6	1409	" "	2.48	9.13	+.27	S.
				8.82	$\pm .33$						8.86	$\pm .30$	

No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.	No.	No. in Table I.	Date.	Reading.	Diff. in Magn.	Resid. in Magn.	Obs.
102. β PEGASI. (1877-78.)							103. γ CEPHEI. (1878.)						
1	740	Dec. 2	1.04	11.02	+.08	P.	1	1660	Feb. 6	1.71	9.94	-.24	P.
2	741	" "	1.05	10.99	+.05	S.	2	1661	" "	1.60	10.08	-.10	U.
3	1261	Jan. 5	1.16	10.78	-.16	P.	3	1681	Feb. 7	1.52	10.19	+.01	P.
4	1262	" "	1.07	10.95	+.01	S.	4	1682	" "	1.59	10.09	-.09	U.
5	1303	Jan. 12	1.07	10.95	+.01	P.	5	1975	Feb. 27	1.49	10.23	+.05	P.
6	1304	" "	1.07	10.95	+.01	S.	6	1976	" "	1.29	10.55	+.37	U.
				10.94	$\pm .05$						10.18	$\pm .14$	

The first and second settings of σ^2 *Orionis* have been bracketed and not included in the mean, as a portion of the light falling on the prism was cut off. The fifth set of measures of ϵ *Lyræ* E has also been rejected, since it was found that the dome cut off a portion of the aperture of the large telescope. The light of the faint star was thus reduced, and the reading rendered too small. The fourth set of μ *Cygni* c has not been retained in the mean, since the seeing was so bad that the set was abandoned after making a single setting. The fifth set of σ^2 40 *Eridani* c has been retained. The comparison is given, by a typographical error in Table I., as if B and c had been observed as one object, which is scarcely possible and not confirmed by the original record.

Table LVII. exhibits the results of Table LVI. in the form of a catalogue. The consecutive columns contain a number for reference, the name of the star, the right ascension and declination for 1875, the position angle and distance of the component, the number of sets observed, and the mean difference in magnitude. The next two columns give the logarithm of the light of the faint star in terms of that of the bright star, and the ratio of the light of the bright star to that of the component. They are computed in the usual way by multiplying the difference in magnitude by four-tenths, and taking the arithmetical complement for the first column and the anti-logarithm for the second. The average deviation of a single set and the probable error of the mean are given in the next two columns. These are followed by the magnitude of the two components. That of the brighter star is taken from the "Uranometria Nova" of Argelander and the "Atlas Coelestis Novus" of Heis. In these catalogues, when the light is expressed by two numbers separated by an inverted period, it denotes that the magnitude lies between the numbers, and nearer the first of the two. Thus, 1.2 denotes that the star is somewhat brighter than 1.5, 2.1 that it is somewhat fainter. The method of equable distribution, described in Volume IX. of these Annals, shows that it will be more correct to represent these magnitudes by 1.4 and 1.6 rather than by 1.3 and 1.7. This follows from the small number of stars to which the intermediate

magnitudes are assigned compared with those designated by a single figure. No change is made in the magnitude of the latter, since it is not deemed advisable to change the unit of the scales adopted by Argelander and Heis. The magnitudes 1, 1.2, 2.1, 2, 2.3, 3.2, 3, &c., will therefore be written 1.0, 1.4, 1.6, 2.0, 2.4, 2.6, 3.0, &c. When the two authorities differ in the estimate of brightness of a star, the mean is taken. An exception is made in the case of the six brightest stars observed. Their light is well known to be much greater than would be represented by the figure 1.0. The following numbers have been assigned to them, derived from the observations of Seidel and Wolff by an extension of the usual scale: α *Aurigæ* = 0.0; β *Orionis* = 0.0; α *Canis Majoris* = -1.5; α *Canis Minoris* = 0.5; α *Bootis* = 0.0; α *Lyræ* = 0.0. These magnitudes are inserted in the last column but one. Adding to them the observed differences in magnitude gives the magnitude of the companions, which are given in the same column. The method just explained has also been employed in reducing several comparisons in Table LVII., made with some other star than that of which the faint star observed was considered as a companion. This reduction was required in sets 3 and 4 of No. 72 (γ *Aquilæ* B), and set 1 of No. 74 (β *Aquilæ* B), where the standard of comparison was α *Aquilæ*; in sets 1, 2, and 3 of No. 75 (ϕ^2 *Cygni* B), which was compared in these sets with α *Cygni*; in sets 1 and 2 of No. 99 (ζ *Pegasi* B), and in set 2 of No. 101 (ξ *Pegasi* c), where α *Pegasi* was employed. The last column is appropriated to remarks. The authority for the position of the companion is given in this column, " β " denoting Burnham, " Σ " Struve, "h" J. Herschel, and "Sm." Smyth. Preference has been given to the order named. "Est." denotes that the positions are those obtained by estimate at the time of observation. They are only approximations intended to identify the object and not to locate it. A number following the authority denotes a catalogue number, unless it is preceded by a comma, when it denotes an estimate of magnitude.

The positions and distances of the small stars, designated as ϵ *Lyræ* E, F, and G, are taken from the diagram and observations on page 8 of the eleventh volume of the Munich Observations. The star 5 *Lyræ* is here taken as the origin of measurements. This diagram is in good agreement with that of Mr. Prince (Monthly Notices, xxxiv. 86). The sketch by Smyth (Cycle of Celestial Objects, ii. 428) was evidently a hasty one.

From the 504 sets of 90 stars, observed more than once, it appears that the average deviation of a single set is .29, and the corresponding probable error of the mean .12.

TABLE LVII.

CATALOGUE OF UNEQUAL DOUBLE STARS.

No.	Name.	R.A., 1875.		Dec., 1875.	Angle.	Dist.	No. of Sets.	Diff. in Magn.	Log.	Ratio.	Av. Dev.	Prob. Err.	Adopted Magns.		Remarks.
		h.	m.										A.	B.	
1	α Androm.	0	2	+28.4	266	65	6	9.62	6.152	7050	.26	.10	2.0, 11.6		$\approx 13^H$.
2	"	"	"	"	"	"	6	9.12	6.352	4450	.32	.12	2.0, 11.1		Repeated.
3	"	"	"	"	"	"	5	8.79	6.484	3280	.40	.17	2.0, 10.8		Aperture 12.7 cms.
4	γ Pegasi	0	7	+14.5	300	181	6	10.58	5.768	17100	.23	.09	2.6, 13.2		B. Sm., 13.
5	"	"	"	"	295	180	6	10.98	5.608	24700	.47	.18	2.6, 13.6		C. Est.
6	ι Ceti	0	13	-9.5	14	45	10	8.84	6.464	3440	.52	.15	3.4, 12.2		h 1953, 12. Sm., 15.
7	δ Androm.	0	33	+30.2	208	122	5	9.33	6.268	5400	.38	.16	3.4, 12.7		B. Sm., 11.5.
8	"	"	"	"	299	28	5	9.39	6.244	5700	.17	.07	3.4, 12.8		C. β . [Heis.
9	α Cassiop.	0	33	+55.9	278	59	5	6.34	7.464	344	.29	.12	2.0, 8.3		$\approx$ Un., 10.0. Var. in
10	γ Cassiop.	0	49	+60.0	348	350	11	11.10	5.560	27500	.33	.09	2.0, 13.1		B. Sm., 13.
11	"	"	"	"	355	240	1	11.70	5.320	47900	—	—	2.0, 13.7		C. Est.
12	"	"	"	"	10	180	1	11.70	5.320	47900	—	—	2.0, 13.7		D. Est.
13	μ Androm.	0	50	+37.8	115	45	5	10.33	5.868	13600	.18	.08	4.0, 14.3		Sm., 16.
14	μ Cassiop.	1	0	+54.3	187	120	2	9.38	6.248	5650	.16	.14	2.0, 11.4		B, α Cass. Est. Sm., 11.
15	β Androm.	1	3	+35.0	100	80	1	10.42	5.832	14700	—	—	2.4, 12.8		B. Est.
16	"	"	"	"	120	35	1	10.85	5.660	21900	—	—	2.4, 13.2		C. Est.
17	"	"	"	"	200	115	1	10.87	5.652	22300	—	—	2.4, 13.3		D. Est.
18	"	"	"	"	208	122	1	10.42	5.832	14700	—	—	2.4, 12.8		E. Est.
19	"	"	"	"	270	40	1	11.33	5.468	34000	—	—	2.4, 13.7		F. Est.
20	"	"	"	"	300	60	1	10.55	5.780	16600	—	—	2.4, 13.0		G. Est.
21	θ Cassiop.	1	4	+54.5	130	150	10	9.36	6.256	5550	.58	.16	2.0, 11.4		B, α Cassiop Est.
22	"	"	"	"	255	280	6	10.04	5.984	10400	.60	.23	2.0, 12.0		C, δ " Est.
23	"	"	"	"	130	90	2	11.33	5.468	34000	.25	.21	2.0, 13.3		D, δ " Est.
24	α Urs. Min.	1	13	+88.6	210	18	6	7.85	6.860	1380	.17	.06	2.0, 9.8		$\approx 93, 9.0$.
25	"	"	"	"	"	"	7	7.30	7.080	832	.45	.16	2.0, 9.3		Aperture 12.7 cms.
26	θ Ceti	1	18	-8.8	60	59	6	10.53	5.788	16300	.17	.06	3.0, 13.5		β .
27	α Arietis	2	0	+22.9	107	282	5	10.21	5.916	12100	.11	.05	2.0, 12.2		Sm., 11.
28	α^2 40 Erid.	4	10	-7.8	108	84	5	8.21	6.716	1920	.18	.08	4.6, 12.8		C, 135°, 6" from B. Sm.
29	"	"	"	"	146	37	6	9.18	6.328	4700	.17	.06	4.6, 13.8		D. β .
30	α Tauri	4	29	+16.3	36	109	5	10.76	5.696	20160	.15	.06	1.0, 11.8		B. $\approx 2^H$, 11.2.
31	"	"	"	"	109	30	1	12.06	5.176	66700	—	—	1.0, 13.1		C. β .
32	α^2 Orionis	4	49	+13.3	48	29	6	9.25	6.300	5010	.34	.13	5.0, 14.2		β .
33	β Eridani	5	2	-5.2	148	120	7	10.36	5.856	13900	.32	.11	3.0, 13.4		Sm., 12.
34	α Aurigæ	5	7	+45.9	151	165	6	10.78	5.688	20500	.27	.10	0.0, 10.8		Sm., 12.
35	β Orionis	5	9	-8.3	2	44	6	12.22	5.112	77300	.38	.14	0.0, 12.2		C. β .
36	"	"	"	"	180	90	2	13.32	4.672	213000	.18	.15	0.0, 13.3		D. Est.
37	τ Orionis	5	12	-7.0	60	36	6	8.16	6.736	1840	.21	.08	4.0, 12.2		B. β . h 2259, 12.
38	"	"	"	"	249	36	7	9.20	6.320	4790	.28	.10	4.0, 13.2		CD. β . h 2259, 14.
39	γ Orionis	5	18	+6.2	150	178	7	12.35	5.060	87100	.22	.08	2.0, 14.4		Sm., 15.
40	α Orionis	5	48	+7.4	155	160	1	10.99	5.604	24900	—	—	1.0, 12.0		Sm., 11.
41	α Can. Maj.	6	40	-16.5	71	10	5	11.93	5.228	59200	.21	.09	-1.5, 10.4		B.
42	"	"	"	"	160	120	2	12.64	4.944	114000	.20	.17	-1.5, 11.1		C. Est.
43	"	"	"	"	114	71	2	13.91	4.436	366000	.12	.10	-1.5, 12.4		D. β .
44	β Can. Min.	7	20	+8.5	310	130	4	10.11	5.956	11100	.32	.16	3.0, 13.1		B. Est.
45	"	"	"	"	80	100	6	10.34	5.864	13700	.24	.09	3.0, 13.3		C. Est.
46	"	"	"	"	40	90	4	10.52	5.792	16100	.25	.12	3.0, 13.5		D. Est.
47	"	"	"	"	80	60	3	12.17	5.132	73800	.15	.09	3.0, 15.2		E. Est.
48	"	"	"	"	80	30	1	12.25	5.100	79400	—	—	3.0, 15.2		F. Est.
49	α Gemin.	7	27	+32.2	162	72	7	8.67	6.532	2940	.25	.09	1.6, 10.3		C. $\approx 4^H$, 9.8.
50	α Can. Min.	7	33	+5.5	317	45	7	11.77	5.292	51100	.11	.04	0.5, 12.3		β .
51	δ Cancri	8	38	+18.6	121	46	4	9.17	6.332	4660	.20	.10	4.0, 13.2		β h , 15. Sm., 15.
52	ι Urs. Maj.	8	51	+48.5	349	14	5	8.34	6.664	2170	.23	.10	3.0, 11.3		h 2477, 13. Sm., 13.

No.	Name.	R.A., 1875.		Dec., 1875.	Angle.	Dist.	No. of Sets.	Diff. in Magn.	Log.	Ratio.	Av. Dev.	Prob. Err.	Adopted Magns.		Remarks.
		<i>h.</i>	<i>m.</i>										A.	B.	
53	δ Leonis	11	7	+21.2	50	107	5	10.39	5.844	14300	.31	.13	2.4, 12.8		Sm., 13.
54	ε Virginis	12	56	+11.6	124	229	6	11.12	5.552	28100	.23	.09	2.6, 13.7		Sm., 15.
55	α Virginis	13	19	-10.5	57	533	5	11.68	5.328	47000	.74	.31	1.0, 12.7		Sm., 10.
56	α Bootis	14	10	+19.8	49	282	5	12.16	5.136	73100	.18	.08	0.0, 12.2		Sm., 11.
57	ρ Bootis	14	26	+30.9	334	60	5	8.77	6.492	3220	.28	.12	3.6, 12.4		β . <i>h</i> , 15.
58	α Serpent.	15	38	+6.8	360	60	5	9.16	6.336	4610	.26	.11	2.4, 11.6		<i>h</i> 1277, 14.15. Sm., 15.
59	η Herculis	16	39	+39.2	265	141	5	8.73	6.508	3100	.28	.12	3.2, 11.9		B. Sm., 10.
60	"	"	"	"	270	100	5	10.79	5.684	20700	.28	.12	3.2, 14.0		C. β .
61	μ Sagittar.	18	6	-21.1	262	12	5	8.03	6.788	1630	.21	.09	4.0, 12.0		D. <i>h</i> 2822, 14. Sm., 16.
62	"	"	"	"	115	50	1	9.21	6.316	4830	—	—	4.0, 13.2		E. β .
63	η Serpentis	18	15	-2.9	77	113	5	7.96	6.816	1530	.48	.20	3.0, 11.0		Σ 8 ^{II} , 12. Sm., 13.
64	α Lyræ	18	33	+38.7	138	43	6	10.97	5.612	24400	.28	.11	0.0, 11.0		β . Σ 9 ^{II} , 10.5. <i>h</i> , 11.
65	"	"	"	"	"	"	7	10.53	5.788	16300	.29	.10	0.0, 10.5		Repeated. [Sm., 11.
66	"	"	"	"	"	"	5	10.38	5.848	14200	.30	.13	0.0, 10.4		Aperture 12.7 cms.
67	"	"	"	"	299	47	2	11.41	5.436	36600	.15	.13	0.0, 11.4		C. β .
68	ε Lyræ	18	40	+39.5	36	130	8	10.85	5.660	21900	.48	.15	0.0, 10.8		E, α Lyræ.
69	"	"	"	"	2	100	6	13.24	4.704	198000	.56	.21	0.0, 13.2		F, α Lyræ.
70	"	"	"	"	339	70	6	13.11	4.756	175000	.58	.22	0.0, 13.1		G, α Lyræ.
71	110 Herc.	18	40	+20.4	109	55	7	8.89	6.444	3600	.18	.06	4.0, 12.9		<i>h</i> 2839, 15. Sm., 16.
72	γ Aquilæ	19	40	+10.3	255	136	7	9.82	6.072	8470	.39	.13	3.0, 12.8		Sm., 12.
73	α Aquilæ	19	45	+8.5	323	153	8	10.03	5.988	10300	.60	.19	1.4, 11.4		Sm., 10.
74	β Aquilæ	19	49	+6.1	16	13	5	9.20	6.320	4790	.26	.11	4.0, 13.2		β .
75	α^2 Cygni	20	10	+46.4	333	20	5	9.52	6.192	6430	.23	.10	4.2, 13.7		B., <i>h</i> 1495, 17. Sm., 16.
76	β Capr.	20	14	-15.2	300	130	7	10.37	5.852	14100	.31	.11	3.0, 13.4		CD. Est. [11.12.
77	β Delphini	20	32	+14.2	344	32	8	8.70	6.520	3020	.73	.23	3.4, 12.1		B. Σ 2704, 11.0. <i>h</i> ,
78	"	"	"	"	"	"	5	7.02	7.192	643	.25	.11	3.4, 10.4		B. Ap. 12.7 cms.
79	"	"	"	"	117	28	6	9.52	6.192	6430	.18	.07	3.4, 12.9		C. β . <i>h</i> , 14. [(12.13?)
80	α Delphini	20	34	+15.5	135	75	6	9.25	6.300	5010	.12	.05	3.6, 12.8		B. β . <i>h</i> 1554, 6.13.
81	"	"	"	"	150	60	5	9.57	6.172	6730	.31	.13	3.6, 13.2		C. Est.
82	"	"	"	"	280	42	5	8.59	6.564	2730	.50	.21	3.6, 12.2		D. β .
83	"	"	"	"	330	48	5	10.26	5.896	12700	.16	.07	3.6, 13.9		E. β . [12.5.
84	α Cygni	20	37	+44.8	102	108	7	11.54	5.384	41300	.12	.04	1.6, 13.1		B. <i>h</i> 1563, 12. Sm.,
85	"	"	"	"	190	150	5	12.49	5.004	99100	.35	.15	1.6, 14.1		C. Est.
86	ε Cygni	20	41	+33.5	321	37	5	9.93	6.028	9380	.21	.09	2.6, 12.5		B. β .
87	"	"	"	"	260	100	5	11.03	5.588	25800	.29	.12	2.6, 13.6		C. Est.
88	η Cephei	20	43	+61.4	30	100	6	9.62	6.152	7050	.20	.08	3.6, 13.2		B. Est.
89	"	"	"	"	30	60	6	10.44	5.824	15000	.45	.17	3.6, 14.0		C. Est.
90	γ Equulei	21	4	+9.6	10	41	5	8.38	6.648	2250	.58	.24	4.6, 13.0		β . [11. Ap. 12.7 cms.
91	δ Equulei	21	8	+9.5	39	27	5	5.79	7.684	207	.34	.14	4.6, 10.4		Σ 2777, 10.2. <i>h</i> , 9.5. Sm.,
92	β Aquarii	21	25	-6.1	323	20	6	9.13	6.348	4490	.09	.03	3.0, 12.1		<i>h</i> 936, 15. Sm., 15.
93	ε Pegasi	21	38	+9.3	327	85	9	10.52	5.792	16100	.26	.08	2.4, 12.9		C. Sm., 14.
94	"	"	"	"	310	50	1	12.04	5.184	65500	—	—	2.4, 14.4		D. Est.
95	μ Cygni	21	38	+28.2	263	35	6	8.82	6.472	3370	.33	.12	4.4, 13.2		C. β .
96	α Pegasi	21	39	+25.1	30	15	2	9.08	6.368	4290	.06	.05	4.0, 13.1		C.
97	α Aquarii	21	59	-0.9	44	116	6	9.70	6.120	7590	.20	.08	3.0, 12.7		<i>h</i> , 13. Sm., 13.
98	γ Aquarii	22	15	-2.0	130	40	6	9.30	6.280	5250	.21	.08	3.5, 12.8		Sm., 14.
99	ζ Pegasi	22	35	+10.2	16	65	6	10.10	5.960	11000	.32	.12	3.4, 13.5		B. Sm., 13.
100	ξ Pegasi	22	40	+11.5	32	110	5	9.06	6.376	4210	.54	.23	4.6, 13.7		B. Sm., 12. [Sm., 15.
101	"	"	"	"	118	12	6	8.86	6.456	3500	.30	.11	4.6, 13.5		C. β . <i>h</i> 301, 12.13.
102	β Pegasi	22	58	+27.4	204	80	6	10.94	5.624	23800	.05	.02	2.4, 13.3		<i>h</i> 1842, 16.17. Sm., 15.
103	γ Cephei	23	34	+76.9	180	60	6	10.18	5.928	11800	.14	.05	3.4, 13.6		Est. [Var. in Heis.

CHAPTER XII.

MISCELLANEOUS OBJECTS.

MEASUREMENTS have been obtained of the light of several of the asteroids. The results are given in Table LVIII. The consecutive columns give a current number, the number in Table I., the date, the hour, the name of the object with which the comparison was made, the corrected reading, the difference in magnitude of the images compared, the constant to be employed, and the difference in magnitude of the observed objects, deduced from the two preceding columns as in previous tables. The next column contains a correction by which, when the asteroid was compared with Mars or Saturn, this difference in magnitude may be reduced to that value which would have been obtained had the circular disk of Mars, at a distance unity from the Sun and from the observer, been the object for comparison. If Saturn was the object used in the comparison, this correction accordingly comprises the separate reductions for the effect of the ring, for the distance of the planet from the Sun and from the observer, and for the ratios of its diameter and albedo to those of Mars. The data for these quantities are given in Chapter III. If Mars was the object used, its phase and distance are considered in forming the correction, as are those of the observed asteroids in computing the corrections contained in the following column, by which the observed differences in magnitude are reduced to the values they would have if each asteroid was at its mean opposition, or at its mean distance a from the Sun and at the distance $a - 1$ from the Earth. In the plane triangle having its vertices at the Sun, Earth, and any planet, let R denote the radius vector of the Earth, r that of the planet, Δ the planet's distance from the Earth, and P the angle between r and Δ . If we regard, as heretofore, the ratio between the quantities of light reflected by any two phases of the planet as equal to that between the areas of their projections on a plane perpendicular to the line of sight, the ratio of the light of any phase to that of the full disk is expressed by $\frac{1}{2}(1 + \cos P)$, since $\cos P$ is the minor semiaxis of the elliptical projection of the terminator. In terms of the three sides of the triangle, $\frac{1}{2}(1 + \cos P) = \frac{(r + \Delta + R)(r + \Delta - R)}{4r\Delta}$. The ratio of the light received from the full disk of the planet to that which would be received from it at mean opposition is $\frac{a^2(a-1)^2}{r^2\Delta^2}$. If M_0 denotes the magnitude of the planet at mean opposition, and M

its observed magnitude, $M_0 - M = \frac{1}{4} \log \frac{a^2(a-1)^2(r+\Delta+R)(r+\Delta-R)}{4r^3\Delta^3}$, since the magnitude increases with the diminution of the light, or $M - M_0 = \frac{1}{4} \log \frac{a^2(a-1)^2(r+\Delta+R)(r+\Delta-R)}{4r^3\Delta^3}$. When the reduction is made to the distance unity, as in the case of Mars, instead of to mean opposition, the factor $a^2(a-1)^2$ is to be omitted. The effect of the phase is nearly inappreciable in most of the observations of the asteroids, but as the value of this term sometimes exceeds a tenth of a magnitude, it has been retained in the reductions.

TABLE LVIII.

OBSERVATIONS OF ASTEROIDS.

No.	No. in Table I.	Date.	Hour.	Standard of Comparison.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Red. to Mars at Distance 1.	Red. to Mean Oppos'n.	Corr. Diff. in Magn. at Mean Oppos'n.	Resid.	Obs.
PALLAS (2). (1878.)													
1	4313	Oct. 16	8.8	λ Aquarii	4.16	3.10	8.72	5.62		-.80	4.82		S.
JUNO (3). (1878.)													
1	4493	Nov. 5	6.4	δ Capr.	3.18	2.51	8.72	6.21		+.30	6.51	-.36	P.
2	4496	" "	6.7	"	3.00	2.39	"	6.33		+.30	6.63	-.24	U.
3	4504	Nov. 6	8.5	"	2.26	1.77	"	6.95		+.29	7.24	+.37	P.
4	4508	" "	9.0	"	2.68	2.14	"	6.58		+.29	6.87	.00	S.
5	4511	" "	9.4	"	3.02	2.40	"	6.32		+.29	6.61	-.26	U.
6	4650	Dec. 7	6.0	"	2.47	1.96	"	6.76		.00	6.76	-.11	P.
7	4651	" "	6.1	"	1.75	1.22	"	7.50		.00	7.50	+.63	S.
											6.87	$\pm .28$	
VESTA (4). (1877.)													
1	341	Oct. 7	8.9	Saturn	6.51	4.07	11.20	7.13	+1.89	-.25	8.77	+.46	P.
2	342	" "	9.0	"	7.35	4.33	"	6.87	+1.89	-.25	8.51	+.20	S.
3	343	" "	9.2	"	6.89	4.19	"	7.01	+1.89	-.25	8.65	+.34	P.
4	344	" "	9.3	"	5.67	3.77	"	7.43	+1.89	-.25	9.07	+.76	S.
5	487	Oct. 23	7.6	"	6.77	4.15	"	7.05	+1.92	-.47	8.50	+.19	P.
6	488	" "	7.6	"	7.54	4.39	"	6.81	+1.92	-.47	8.26	-.05	U.
7	489	" "	7.8	Mars	2.82	2.25	"	8.95	-.47	-.47	8.01	-.30	U.
8	490	" "	8.0	"	3.19	2.52	"	8.68	-.47	-.47	7.74	-.57	P.
9	647	Nov. 18	9.1	"	3.29	2.59	"	8.61	+.22	-.87	7.96	-.35	P.
10	648	" "	9.2	"	3.28	2.58	"	8.62	+.22	-.87	7.97	-.34	S.
11	649	" "	9.3	"	3.09	2.45	"	8.75	+.22	-.87	8.10	-.21	P.
12	650	" "	9.4	Saturn	6.74	4.14	"	7.06	+2.00	-.87	8.19	-.12	P.
13	651	" "	9.5	"	6.53	4.07	"	7.13	+2.00	-.87	8.26	-.05	S.
											8.31	$\pm .30$	

No.	No. in Table I.	Date.	Hour.	Standard of Comparison.	Reading.	Diff. in Magn. of Images.	Constant.	Diff. in Magn. of Objects.	Red. to Mars at Distance 1.	Red. to Mean Oppos'n.	Corr. Diff. in Magn. at Mean Oppos'n.	Resid.	Obs.
ANTIOPE (90). (1877.)													
1	210	Sept. 16	10.2	Mars	13.28	3.19	10.70	13.89	-1.32	+ .73	13.30	- .60	P.
2	211	" "	10.3	"	18.16	2.53	"	13.23	-1.32	+ .73	12.64	-1.26	S.
3	212	" "	10.4	"	10.67	3.66	"	14.36	-1.32	+ .73	13.77	- .13	P.
4	213	" "	10.5	"	15.56	2.86	"	13.56	-1.32	+ .73	12.97	- .93	S.
5	219	Sept. 18	9.4	Saturn	30.74	1.46	"	12.16	+1.89	+ .71	14.76	+ .86	P.
6	220	" "	9.5	"	42.10	.87	"	11.57	+1.89	+ .71	14.17	+ .27	R.
7	221	" "	9.6	"	38.06	1.05	"	11.75	+1.89	+ .71	14.35	+ .45	R.
8	222	" "	9.9	"	35.64	1.17	"	11.87	+1.89	+ .71	14.47	+ .57	S.
9	223	" "	10.3	Mars	9.04	4.02	"	14.72	-1.29	+ .71	14.14	+ .24	P.
10	224	" "	10.4	"	7.61	4.39	"	15.09	-1.29	+ .71	14.51	+ .61	S.
11	515	Oct. 30	7.3	Saturn	2.12	1.63	13.50	11.87	+1.94	+ .24	14.05	+ .15	P.
12	516	" "	7.4	Mars	.86	9.67	"	13.83	- .28	+ .24	13.79	- .11	P.
13	517	" "	7.5	"	.91	9.80	"	13.70	- .28	+ .24	13.66	- .24	U.
14	518	" "	7.6	Saturn	2.15	1.66	"	11.84	+1.94	+ .24	14.02	+ .12	U.
											13.90	± .47	
BRUNHILD (123). (1877.)													
1	559	Nov. 7	10.2	β Arietis	4.40	3.22	13.50	10.28		+ .49	10.77	+ .52	S.
2	560	" "	10.3	"	5.03	3.51	"	9.99		+ .49	10.48	+ .23	P.
3	561	" "	10.4	"	7.92	4.49	"	9.01		+ .49	9.50	- .75	U.
											10.25	± .50	
EVA (164). (1878.)													
1	1695	Feb. 7	10.8	β Aurigæ	.50	8.50	11.10	12.60		-.36	12.24	+ .34	U.
2	1696	" "	10.9	"	.62	8.96	"	12.14		-.36	11.78	- .12	P.
3	1697	" "	11.0	"	.60	8.89	"	12.21		-.36	11.85	- .05	U.
4	1698	" "	11.1	"	.64	9.03	"	12.07		-.36	11.71	- .19	P.
											11.90	± .18	
MENIPPE (188). (1878.)													
1	3028	June 26	10.6	γ Libræ	2.24	1.75	11.10	9.35		+ .92	10.27	- .30	P.
2	3029	" "	10.8	"	1.70	1.15	"	9.95		+ .92	10.87	+ .30	U.
											10.57	± .30	

Table LIX. exhibits the dimensions of the observed asteroids which result from the differences of magnitude obtained in Table LVIII. The first four columns contain a number for reference, the name and number of the asteroid, the object with which it was compared, and the magnitude adopted for that object. If it was a star, the magnitude is taken from the estimates of Argelander and Heis, as explained above, p. 288. If the object is Mars at distance unity, as shown in Table LVIII, the magnitude is found by reducing Zöllner's value for the mean opposition (see p. 276) to the

distance unity. The fifth and sixth columns contain the number of sets and the mean difference of magnitude, both taken from Table LVIII. The next three columns give the corresponding magnitude of the asteroid (found by adding the mean difference of the sixth column to the adopted magnitude given in the fourth), the average deviation of one set from the mean, and the probable error of the mean of the sets. The remaining columns give the diameter of each asteroid in various units, on the assumption that its albedo is equal to that of Mars. The units adopted are the diameter of Mars, the second of arc at the mean opposition of the asteroid, the kilometre, and the mile. Each expression is followed by the amount of the variation corresponding to the probable error previously found, except in the first line of the Table, where the observation was confined to a single set. The data used (pp. 237, 269) to compute previous Tables of the same kind have been retained. A change in the adopted diameter of Mars would alter the results except in so far as they depend upon the observations in which Saturn was the standard of comparison.

TABLE LIX.

DIMENSIONS OF ASTEROIDS DERIVED FROM PHOTOMETRIC OBSERVATIONS.

No.	Name.	Standard of Comparison.	Adop. Magn.	No. of Sets.	Mean Diff. in Magn.	Result in Magn.	Av. Dev.	Pr. Err.	Equivalent Diameter.			
									In Diam. of Mars.	Angle at Mean Opp.	In Kilometres.	In Miles.
1	Pallas (2)	λ Aquarii	4.0	1	4.82	8.82			.0368	.2099	269	167
2	Juno (3)	δ Capr.	3.0	7	6.87	9.87	.28	.10	.0207 $\pm$.0010	.1250 $\pm$.0058	151 $\pm$ 7	94 $\pm$ 4
3	Vesta (4)	Mars	-1.8	13	8.31	6.51	.30	.07	.0701 $\pm$.0023	.5200 $\pm$.0168	513 $\pm$ 17	319 $\pm$ 10
4	Antiope (90)	Mars	-1.8	14	13.90	12.10	.47	.11	.0112 $\pm$.0006	.0526 $\pm$.0027	82 $\pm$ 4	51 $\pm$ 3
5	Brunhild (129)	β Arietis	3.0	3	10.25	13.25	.50	.30	.0044 $\pm$.0006	.0265 $\pm$.0037	33 $\pm$ 5	20 $\pm$ 3
6	Eva (164)	β Aurigæ	2.0	4	11.90	13.90	.18	.09	.0031 $\pm$.0001	.0192 $\pm$.0008	23 $\pm$ 1	14 $\pm$ 1
7	Menippe (188)	γ Libræ	4.4	2	10.57	14.97	.30	.25	.0027 $\pm$.0003	.0135 $\pm$.0016	20 $\pm$ 2	12 $\pm$ 1

The failure to discover a satellite to the planet Venus suggests the determination of the maximum light which such a body might reflect without rendering it visible in our largest telescopes. Observations for this purpose were made with Photometer E on Nov. 13, 1877, and with Photometer J on Dec. 26, 1877, and on Jan. 28, 1878. The images of Venus formed by the small telescope, and reflected from the plate of glass in the eye-piece, resembled minute stars or satellites, which could be diminished at will by turning the screw. They could be removed to any required distance from Venus, which could also be placed behind an opaque circular screen if desired. It was then only necessary to find the smallest reading of the screw at which they were visible.

The problem is not wholly determinate, since the darker the sky the fainter would be the limit of vision, but on the other hand Venus would be nearer the horizon, and consequently the increasing distortion of the atmosphere would increase the difficulty of seeing a real satellite, without affecting the visibility of the reflected image. Moreover, the nearer the satellite is to the planet the brighter it must be for visibility. As Venus has its greatest brightness when presenting the form of a crescent, a satellite, even if grazing the surface, would be at one of its elongations at least a semidiameter of the planet distant from the illuminated portion. In this case, however, the satellite would be concealed by the shadow of the planet. In order that the satellite might be visible at an apparent distance from the centre of the planet equal to its radius, it would be necessary that its real distance, or the radius of its orbit, should be at least equal to $R \operatorname{cosec} \frac{1}{2} v$, in which R is the radius of Venus and v the angle between the Earth and Sun as seen from Venus. If $v = 90^\circ$, or Venus presented the phase of a half moon, a satellite having a radius of orbit greater than $1.4 R$ might be seen at a distance of $\frac{1}{2} R$ from the centre. If $v = 120^\circ$, and the width of the crescent was accordingly $\frac{1}{2} R$, any radius of orbit greater than $1.16 R$ would be sufficient. In other words, if the satellite was more than 1000 kms. (600 miles) from the surface of the planet, it might be visible at a distance from the illuminated portion of Venus equal to $\frac{1}{2} R$. In Table LX., the consecutive columns give a current number, date, hour, reading, difference in magnitude, corresponding equivalent diameter in kilometres and miles, initial of observer, and remarks. These last generally relate to the visibility of the reflected image at the given setting. C denotes that the planet was concealed by placing it behind an opaque screen. The distance of the image from the centre of Venus in terms of the radius of the latter is also given in some cases in this column. When not otherwise specified, this distance was generally equal to the radius.

It is very improbable that Venus is attended by a satellite as bright as the smallest of these settings would represent. Such an object could scarcely have escaped detection when looked for under the most favorable circumstances. The corresponding light would be only one four-millionth part of that of Venus, and the equivalent diameter less even than that of either satellite of Mars. Unless its albedo was far less than that of Venus, it would be useless to look for it during transit over the Sun, as its equivalent diameter in 1882 would be only $0''.03$.

A few measures were made of the limit of visibility of various objects, by reducing their images reflected in the small telescope of the photometer until they were barely visible. This was sometimes done when a very faint object had been measured to see if a true comparison was obtained, or if the reflected image was simply reduced to the point where it ceased to be visible. A comparison of these

TABLE LX.
ARTIFICIAL SATELLITE OF VENUS.

No.	Date. 1877-78.	Hour.	Reading.	Difference in Magnitude.	Equiv. Diam.		Obs.	Remarks.
					Kilom.	Miles.		
1	Nov. 13	5.3	2.09	14.80	13	8	P.	Just visible.
2	" "	5.3	3.32	13.79	21	13	P.	Easily seen.
3	" "	5.3	2.21	14.68	14	9	P.	Just visible. Distance 3.
4	" "	5.3	2.44	14.46	15	10	P.	Easily seen. Distance 3.
5	" "	5.3	3.91	13.44	25	15	P.	
6	" "	5.4	1.72	15.22	11	7	P.	C. Distance 2.
7	" "	5.4	2.11	14.78	13	8	P.	C. Easily seen. Distance 2.
8	" "	5.4	6.07	12.48	38	24	P.	Distance 25.
9	" "	5.5	1.67	15.29	11	7	S.	C. Just seen.
10	" "	5.5	1.53	15.48	10	6	S.	C. Just seen. Distance 2.
11	" "	5.5	1.66	15.30	10	7	S.	C. Easily seen. Distance 2.
12	" "	5.5	1.84	15.08	12	7	S.	C. Easily seen.
13	" "	5.6	2.32	14.57	15	9	S.	Just visible.
14	" "	5.6	2.12	14.77	13	8	S.	Just visible. Distance 2.
15	" "	5.6	2.40	14.50	15	9	S.	Easily seen. Distance 2.
16	" "	5.6	2.76	14.20	17	11	S.	Easily seen.
17	" "	5.6	3.79	13.51	24	15	S.	Glimpses. Distance .25.
18	Dec. 26	5.2	.75	14.62	14	9	P.	Easily seen. Very distant.
19	" "	5.3	.75	14.68	14	9	P.	C.
20	" "	5.3	1.00	14.00	19	12	P.	Followed to distance .5.
21	" "	5.3	.50	15.50	10	6	P.	C. Could hardly be missed.
22	" "	5.4	1.00	14.00	19	12	P.	C. Could not be missed.
23	" "	5.4	.55	15.30	10	7	P.	Perceptible.
24	" "	5.5	.75	14.62	14	9	P.	Easily seen. Distance .5.
25	" "	5.6	.52	15.42	10	6	P.	Clearly seen.
26	" "	5.6	.40	15.99	8	5	P.	Glimpsed.
27	" "	5.7	.43	15.83	8	5	S.	Could hardly be missed.
28	Jan. 28	6.0	.88	14.28	17	10	P.	Distinctly visible. Distance .5.
29	" "	6.0	.73	14.68	14	9	P.	Just visible.
30	" "	6.0	.76	14.60	15	9	P.	Just visible.
31	" "	6.0	.79	14.51	15	9	P.	Distinctly visible.
32	" "	6.1	1.00	14.00	19	12	P.	Could not be missed.
33	" "	6.1	.78	14.54	15	9	P.	C. Below Venus.
34	" "	6.1	.34	16.34	6	4	P.	C. Seen faintly.
35	" "	6.1	.44	15.78	8	5	P.	Followed to .44.
36	" "	6.1	.31	16.54	6	4	P.	Glimpsed.
37	" "	6.2	.31	16.54	6	4	P.	Detected at .31.
38	" "	6.2	.79	14.51	15	9	P.	Distinctly seen.
39	" "	6.2	.62	15.04	12	7	P.	C. Distinctly visible.
40	" "	6.2	.63	15.00	12	7	P.	C.
41	" "	6.2	.80	14.48	15	9	P.	Seen at a glance.
42	" "	6.3	.75	14.62	14	9	P.	
43	" "	6.3	1.00	14.00	19	12	P.	Very bright.
44	" "	6.3	.41	15.94	8	5	P.	C. Easily seen.
45	" "	6.4	.44	15.78	8	5	S.	C. Distinctly visible.
46	" "	6.4	.42	15.88	8	5	S.	C. Limit of visibility.
47	" "	6.4	.54	15.34	10	6	S.	Distinctly visible.
48	" "	6.5	.49	15.55	9	6	S.	Limit of visibility.

observations is given in Table LXI. The successive columns give a current number, the number in Table I., the date, the object, its magnitude deduced by the method of pages 276 and 288, the observed reading when reduced to the limit of visibility, the difference in magnitude of the object and its reduced image, and the sum of the fifth and seventh columns, or the adopted magnitude of the limit of visibility. The last three columns give the name of the faint object which had been previously measured, the excess of its brightness over the limit just obtained, and the initial of the observer.

TABLE LXI.
OBSERVATIONS OF LIMIT OF VISIBILITY.

No.	No. in Table I.	Date. 1877-78.	Object.	Adopted Magn.	Reading.	Diff. in Magn. of Objects.	Magn.	Object previously Observed.	Diff.	Obs.
1	733	Dec. 2	α Cygni	1.6	.30	13.71	15.31	α Cygni B	+2.21	P.
2	735	" "	"	1.6	.37	13.26	14.86	"	+1.78	S.
3	1606	Feb. 3	α Tauri	1.0	.47	12.74	13.74	α Tauri c	+ .70	P.
4	3334	July 21	α Bootis	0.0	.27	13.94	13.94	α Bootis B	+1.77	P.
5	4423	Oct. 26	α Arietis	2.0	.50	12.60	14.60	Sat. Nept.	+ .43	S.
6	4429	Oct. 28	"	"	.38	13.20	15.20	" "	+ .95	P.
7	4430	" "	"	"	.47	12.74	14.74	" "	+ .26	S.
8	4431	" "	"	"	.39	13.14	15.14	" "	+ .58	U.
9	4448	Nov. 1	Saturn	0.95	.21	14.49	15.44	Hyperion	+ .38	S.
10	4458	Nov. 2	"	0.95	.35	13.38	14.33	"	+ .06	P.
11	4597	Nov. 23	"	0.87	.75	11.72	12.59	Mimas	+ .37	P.
12	4599	" "	"	0.87	.25	14.11	14.98	Hyperion	+1.13	P.
13	4600	" "	"	0.87	.30	13.71	14.58	"	+ .45	S.
14	4607	Nov. 24	"	0.87	.23	14.21	15.08	"	+ .89	S.
15	4609	" "	"	0.87	.26	14.02	14.89	"	+ .98	P.

The faint star was generally near enough to a brighter star or planet to cause an apparent reduction in its light. The reflected image was therefore placed symmetrically with it as regards the brighter object. The effect is most marked in set 11, in which the limit of visibility appears very bright owing to the proximity of Saturn. As most of the numbers in the eighth column would be increased if the background was dark, it appears probable that under favorable circumstances a star of the fifteenth magnitude would be visible in our telescope. Such a star would give a light equal to one-millionth of β Orionis, α Lyrae, α Bootis, or α Aurigae, or one ten-thousandth part of the light of an average fifth-magnitude star. The variation in the separate results confirms the opinion already expressed, that large variations are to be anticipated in observations of the limit of visibility by different persons on different nights.

The object-glass was removed from its cell and cleaned several times during these measurements. On one of these occasions on Sept. 15, 1879, the opportunity was taken to measure the amount of light cut off by the objective, and also the increased

transparency after it had been cleaned. The method employed was that described on page 214 for determining the constant of Photometer I. Twelve readings were made in each set, the first and last being taken with the full aperture, and the others with the ten plates numbered 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, and 5.0. Since the relative and not the absolute readings are required, the mean of the twelve in each set may be used. Sets were taken by Mr. Searle and myself before and after the object-glass had been removed, and also after it had been cleaned and replaced. The mean readings obtained by Mr. Searle in these three cases were 1.65, 1.71, and 1.65; my own were 1.38, 1.56, and 1.42. Multiplying the logarithms of these numbers by five to reduce them to magnitudes, we conclude that the loss of light caused by the object-glass before cleaning was .07 and .27 according to the two observers; after cleaning, it became .07 and .21. The effect of the dust on the object-glass may therefore be neglected. The light cut off by the glass is less than was anticipated. This result was thought to be due to the light of the sky shining obliquely on the object glass, and reflected diffusely from it. It is obvious that if the Sun shone in this way on the lens it would illuminate it so that its brightness would be much increased. This explanation was tested but not confirmed by sets 4124 to 4129, and sets 4232 to 4237. The West Equatorial was used, in which the effect should have been more marked, as the object-glass was exposed to a larger portion of the sky. When the shutters were opened wide the objective cut off .33 of a magnitude. Excluding the stray light the difference was .24, or less than before. The difference, if any, seems therefore counterbalanced by errors of observation. The mean of the four determinations of the light cut off by the objectives gives .21. Admitting that the loss of light for each lens of an object-glass is the same as that caused by a prism, we obtain from Fresnel's formula, as is shown on pages 2 and 206, the theoretical value .23.

The early observations of Jupiter's satellites and of double stars have not been reduced, since care was not taken to arrange the images symmetrically during the measurement. An attempt was made to determine the thickness of Saturn's ring at the time of its disappearance in February, 1878, by the following method. The image of Saturn was reduced to a faint line by placing a cylindrical lens near the prism in the eye-piece of Photometer I. This line could then be reduced until it was no brighter than the ring. A measurement of the focus and position of the cylindrical lens would serve to deduce the corresponding reduction in the light of Saturn. Unfortunately the disappearance of the ring occurred at a time when Saturn was so nearly in conjunction with the Sun that satisfactory measures of this kind could not be obtained.

Numerous measurements have also been made of the variation in light of the satellites of Jupiter while undergoing eclipse. The discussion of these observations, which are still in progress, will be reserved for a future volume.

APPENDIX A.

CONSTRUCTION OF A CHART FOR FINDING ALTITUDES, &c.

FOR a station at any considerable distance north of the equator, a chart such as that mentioned in Chapter III. may conveniently be constructed by projecting the celestial sphere upon the plane of the equator, the point of sight being at the south pole. The projection will accordingly be stereographic, the north pole will be projected at the centre of the circle representing the equator, the diameters of which represent hour circles, and, if its radius is taken as the unit of measurement, the radius of any projected parallel of declination at a polar distance $90^\circ - \delta$ will be $\tan \frac{1}{2} (90^\circ - \delta)$. If the latitude is denoted by ϕ , the projection of the zenith will accordingly be on the diameter representing the meridian at a distance $\tan \frac{1}{2} (90^\circ - \phi)$ from the projection of the pole. The intersections with the meridian of any circle of equal altitude having a zenith distance ζ will be projected at distances $\tan \frac{1}{2} (90^\circ - \phi + \zeta)$ and $\tan \frac{1}{2} (90^\circ - \phi - \zeta)$ from the projection of the pole; and, as the projection is stereographic, the circle will be projected as a circle, with its centre on the diameter representing the meridian, and with a radius $\frac{1}{2} \{ \tan \frac{1}{2} (90^\circ - \phi + \zeta) - \tan \frac{1}{2} (90^\circ - \phi - \zeta) \}$. If its altitude is denoted by A , the expression is reduced to $\frac{1}{2} \{ \cot \frac{1}{2} (A + \phi) - \tan \frac{1}{2} (A - \phi) \}$. The projection of the horizon will have a radius denoted by $\frac{1}{2} (\cot \frac{1}{2} \phi + \tan \frac{1}{2} \phi)$, and will form the boundary of the required chart. Azimuths may be found by projecting a series of circles passing through the projections of the zenith and nadir. The latter lies on the meridian at a distance from the pole equal to $\tan \frac{1}{2} (90^\circ + \phi)$, in the direction opposite to that of the projected zenith.

The loci of points having equal parallactic angles will not be circles, and cannot therefore be constructed with advantage on this chart. These angles may be found by the help of the polar triangle corresponding to that formed by the zenith, pole, and star. The chart described above may be used by drawing on it a series of great circles inclined at the constant angle of $90^\circ - \phi$ to the meridian. That circle intersecting the meridian at a distance from the pole equal to the supplement of the hour angle, will form one side of the required polar triangle. The other sides will be formed by the meridian and the hour circle inclined to it by the angle $90^\circ + \delta$. The parallactic angle or its supplement may then be read off, as was the north polar distance in the previous construction. As it is somewhat difficult to construct the series of circles inclined at equal angles to the meridian, the following method may be preferred. Project the polar triangle on the great circle corresponding to the supplement of the hour angle, and from any point of it project the series of great circles passing through it, and of small circles of which it is the pole. Project also the series of great circles equally inclined to the first circle. These three series serve to determine the corresponding declinations, parallactic angles, and hour angles.

APPENDIX B.

MINUTE HOLES.

THE first attempt to form the minute circular holes mentioned on p. 197 was made by laying a piece of tin-foil on a plate of glass with a sheet of tissue paper between them. The hole was then pierced by a sharp cambric needle pressed lightly against the foil. The point of the needle being nearly conical, the hole was a section of the cone at a distance from its apex equal to the thickness of the tissue paper. A hole was thus formed which was nearly circular, but the burr adhered to one edge. Two measurements of its diameter with different objectives gave .00280 and .00283 cms. The holes were distinguished by assigning a letter to each plate containing them, and numbering the separate perforations. This hole was named A 1, and was used on August 27. The next day a minute square aperture was formed by laying a piece of tin-foil on a plate of glass, and cutting a fine line in it with a sharp knife. This was nearly covered by two strips of foil placed at right angles to the line, and brought very near each other by hand. The area of this hole, B 1, was found with difficulty on account of the difference in focus of its edges caused by the thickness of the foil. A measurement gave its area equal to that of a circle having a diameter of .0037 cms. It was only used on August 28. C 4 was drilled in a plate of platinum by a cambric needle filed to a point and twirled between the fingers. Its diameter was .00599 cms. It was used on August 30. The plate J, which was used on September 4, was perforated in a similar manner. It contained six holes, one of which, J 6, was exceedingly minute. Its area equalled that of a circular hole .00043 cms. in diameter; this was the smallest aperture used. Unfortunately, on examination under the microscope, this hole proved to be only a crack where an unsuccessful attempt had been made to drill a circular hole. There is much doubt as to which hole was actually employed on September 4. That named in the records is J 1, which has a diameter of .00874 cms. It is not improbable that the observations were really made with J 5, diameter .00252 cms. M 2 was also used on September 4, although somewhat irregular in shape; its mean diameter was found to be .0012 cms.

Various other plans were proposed, and some of them tried, for making suitable holes. For instance, drilling a somewhat larger hole and reducing its size by pressure. This, however, gave an irregular aperture. A somewhat better result was obtained by burnishing, but the hole remained too large. Various chemical or physical devices were suggested; for instance, subjecting silver leaf or tin-foil to the spray of an atomizer fed by nitric acid or the fumes of boiling mercury. Again, it was thought that an electric discharge of sufficient power might melt the edges of a hole through which it should pass, and that a circular aperture would then be produced by capillarity. The minute hole formed by drawing out a glass tube was also suggested.

After trying over a hundred holes made by the various methods described above, it was found that the results were no better than those obtained by the first method. The holes

were not smaller or more nearly circular, although, the metal plates being thicker, they might be somewhat less liable to change their form. There is, however, the objection to a thicker plate that the penumbra of the edges of the hole may reduce the virtual area.

The hole Q 1, which was used on September 8-11, was made with a needle in tin-foil like A 1. An examination under the microscope showed that it was not circular in shape. Its greatest and least diameters were determined on September 8 with a $\frac{1}{2}$ inch objective, and the mean taken as the diameter of a circle of equal area. This gave as a result .00127 cms. On September 10, a wholly independent and more careful measurement was made with a $\frac{1}{8}$ inch objective. Beside direct measures with a scale in the eye-piece, a camera lucida was used, and the drawing of the hole and scale compared. The result thus obtained (.00130 cms.) was thought to be entitled to double weight, and the diameter employed in the computations is .00129 cms.

The problem of making a sufficiently minute circular hole was finally completely solved by Mr. Charles V. Woerd, Superintendent of the American Watch Co. A piece of platinum foil was rolled out to a thickness of about .004 cms. and attached to a plate of glass by gum arabic. A piece of steel was tempered as hard as possible and turned in a lathe to a conical point having an angle at the vertex of about 30° . The grinding was effected by a lap with diamond powder. The hole was bored by pressing the platinum plate by hand against the steel point while rotating, and without removing it from the lathe. If once taken out it would be impossible to centre it again with sufficient precision. In order to protect the plate from dust, it was immediately mounted under a cover glass in Canada balsam like a microscope slide.

Thirteen holes were made in this way on September 12 in a plate which will be denoted by R. The third of these holes, hereafter designated by R 3, was more perfect than the others. Its diameter was a little over a thousandth of a centimetre, and its deviation from the circular form probably at no point exceeded one per cent of its diameter. On the afternoon of September 12, the diameter of this hole was measured with an eye-piece micrometer attached to a microscope having an objective of $\frac{1}{8}$ inch. The value of one division of the micrometer was found by measuring ten of the divisions of a glass scale of hundredths of an inch. The results varied between 185.1 and 186.1 divisions of the micrometer, the mean result, which was adopted, being 185.74 divisions. The value of one division of the micrometer is, accordingly, .0001367 cms. Five measurements were made of the diameter of the hole, after each of which the micrometer was turned 45° , so that the first and fifth measurements were made along the same diameter. The results were 10.1, 10.0, 9.9, 10.1, and 10.1, the mean of which makes the diameter of the hole .001372 cms. An approximate measure with a $\frac{1}{2}$ inch objective gave .00143 cms. These measurements were made by Professor W. A. Rogers.

On the evening of Jan. 15, 1878, a more accurate determination of the diameter of this hole was made. A microscope was used with a stage movable by a carefully constructed micrometer screw by Merz. A $\frac{1}{8}$ inch objective was employed, and two eye-pieces giving powers of 560 and 870 respectively. A scale divided into thousandths of an inch was inserted in the first of these eye-pieces, and the second was attached to a filar micrometer. The settings were made by Professor Rogers, who has described this instrument more in detail in the American Quarterly Microscopical Journal, i, 208. The comparisons were made with a scale ruled by Professor Rogers, having 100 lines to the inch, each fifth space being divided to thousandths of an inch, which were taken as units of measurement. The first measures were made with the eye-piece micrometer. Eight diameters were measured at intervals of 45° ; the last four should therefore be identical with the first four. They are given in columns one and two of Table LXII. Their

mean equals 16.97 divisions. To determine the value of one division the intervals of eleven lines, a thousandth of an inch apart, were measured with results given in the first column of Table LXIII. The mean equals 34.79, and the resulting diameter of the hole equals .001239 cms. The next measurement was made with the screw attached to the stage. The

TABLE LXII.

Eye-piece Micrometer.		Filar Micrometer.	
17.1	17.0	127.12	127.94
17.1	17.0	126.42	127.90
16.9	16.9	126.36	124.45
16.9	16.9	125.90	125.10
17.00	16.95	Mean by weights 126.57	
Mean 16.97			

diameter measured was that parallel to the edge of the plate, and the mean of five settings in different parts of the screw gave 3.56 divisions. A measurement of the scale gave 7024 divisions as the value of one inch. This gives .001286 cms. as the horizontal diameter of the hole. Eight sets of measures were next made of diameters at equidistant intervals of 45° , with the eye-piece filar micrometer. The results are shown in columns three and four of Table LXII. Their mean is 126.57, giving weights proportional to the number of settings. The first five sets consist of five measures each, the last three of two each. Ten preliminary measures gave 249940 divisions as the value of one inch. Eight sets of two measures each were then made of the intervals of three one-thousandths of an inch between the lines 0 and 3, 1 and 4, 2 and 5, &c. The mean of the results which are given in Table LXIII., column two, gives 251500 divisions

TABLE LXIII.

$\frac{1}{1000}$ inch.	$\frac{3}{1000}$ inch.
35.3	755.05
34.6	754.90
34.8	756.65
34.7	755.40
35.0	753.90
34.3	753.50
35.0	753.25
35.0	753.35
34.4	754.50
34.8	
34.79	251.50

as the value of one inch. Combining this with the value deduced from the preliminary set, with weights proportional to the number of settings, we have 250900 divisions to the inch. Hence the diameter of the hole from these measures equals .001281 cms.

That the hole is not perfectly circular is obvious on carefully examining the image under the high powers used, but the deviations are so slight as to be scarcely perceptible by measurement. A comparison of the horizontal diameters, or those first measured in the first and third

methods, shows that they exceed the mean by .000006 cms. and .000010 cms. respectively. Accordingly the measurement by the stage micrometer screw should be reduced by .000008 cms., the mean of the quantities just obtained. The resulting value is .001278 cms., or nearly the same as that given by the other screw. The mean of the values .001239, .001281, and .001278 obtained by these three independent methods, is .001266, with a mean deviation of .00002 cms. To make sure that there was no anomalous change in diameter, due to changes of temperature, the scale and hole were measured first at 26° C, and again at -10° C. The glass scale changed from 50.4 to 50.1 and the diameter of the hole from 17.0 to 16.87. The equality of these proportions is probably accidental. The accuracy of the measurements as well as of the ruling may be tested by comparing the separate numbers in Table LXIII., since they represent different intervals. The first column shows that the mean deviation equals 0.23 of a division, or .000017 cms. The mean deviation of the individual observations of which column two is formed is 1.05 divisions, or .000011 cms. Since the probable error of a single measurement is somewhat less than this, it may be affirmed that this error, including errors of ruling, is not likely to exceed one hundred-thousandth of a centimetre.

Since the hole is mounted in Canada balsam between glass plates, about one-tenth of the light passing through it is always lost by reflection and absorption. It will accordingly allow no more light to pass through it than an unobstructed hole having a diameter .949 as great. It will therefore be equivalent to a hole having a diameter equal to $.001266 \times .949$, or .001202 cms.

The discordance of the result on September 12 from that obtained on January 15 is too great to be explained by accidental error. It must therefore be due either to a mistake in the measurement or to a real change in the hole. In support of the first view it will be noticed, that if the number of divisions of the micrometer, answering to the diameter of the hole, was erroneously counted as ten instead of nine, the diameter of the hole as measured in September would be .001235 cms., which agrees very closely with the measurement of January 15. On the

TABLE LXIV.

No.	Date. 1878.	Hole 8.	Hole 9.	Scale 1.	Scale 2.	Diameter. Hole 8.	Diameter Hole 9.
1	Jan. 28	26.72	17.28	65.69	65.69	.002033	.001315
2	Jan. 29	26.74	17.33	65.89	65.94	.002028	.001315
3	Jan. 30	26.75	17.08	66.21	66.20	.002020	.001290
4	Jan. 31	26.72	16.86	65.88	65.79	.002029	.001280
5	Feb. 1	26.79	16.97	65.90	65.92	.002029	
6	Feb. 6	26.88	17.33	65.95	66.10	.002028	.001312
7	Feb. 13	26.84	17.71	65.98	66.02	.002026	.001342
8	" "	27.03	17.49	"	"	.002048	.001325

other hand, Professor Rogers suggests that the hole being conical in shape, its sharp edge would be pressed down as the balsam, in which it is mounted, contracts, and that accordingly during several days after it was mounted, its diameter might diminish. To test this theory, another series of holes was made on January 24, and measured by the apparatus used in the first measures of January 15. The plate was denoted by T, and holes 8 and 9 were selected as the most perfect. The first column in Table LXIV. gives the current number, the second the date, the third and fourth the diameters of holes 8 and 9 in divisions of the micrometer. The fifth and

sixth columns give two independent measurements of a scale of two-hundredths of a centimetre. Each is the mean of the measurements of ten intervals, so that errors of ruling are almost completely eliminated. The seventh and eighth columns give the diameters of the holes reduced to centimetres, using the mean of columns five and six.

The first measurement of hole 8 is the mean of five readings only. After the seventh of the above measurements, the plate was heated so as to completely harden the balsam. Although these measures show no appreciable progressive change in the diameters of the holes, the form of No. 8 appeared to alter, an imperfection on one edge becoming more marked.

Whatever occasioned the difference in the measures of R 3, it is evident that those of January 15 are to be employed. Not only were they taken more carefully, but a similar result was obtained by three wholly independent methods; and if the hole really changed its form, the alteration probably took place before many photometric measurements had been made with it.

The hole R 1 was used on the evening of Sept. 13, 1877. The mean of three measures of its diameter gave 3.30 divisions of the head of the lower screw of the micrometer, and the same screw gave a diameter perpendicular to the first of 3.37 divisions. The difference seems to indicate a perceptible ellipticity of the hole. The above measurements correspond to diameters

TABLE LXV.

Name of Hole.	Adopted Diameter.	
	In Centimetres.	In Seconds.
A 1	.00281	0.850
B 1	.00370	1.117
C 4	.00599	1.809
J 1	.00874	2.639
J 5	.00252	0.761
J 6	.00043	0.130
M 2	.00120	0.362
Q 1	.00129	0.390
R 1	.00336	1.015
R 3	.00120	0.363

of .00350 and .00357 cms., the mean of which, .00354 cms., will be assumed as the diameter of the hole. The effective diameter will be found as in the case of R 3, by multiplying the measured diameter by .949, to allow for absorption and reflection. The result is .00336 cms.

The results of the preceding discussion are exhibited in Table LXV. In finding the number of seconds of arc subtended by the diameter of each hole at the principal focus of the East Equatorial, the logarithm of the focal length of that telescope, expressed in centimetres, is assumed to be 2.834. The logarithm of the radius in seconds of arc is 5.314; the logarithm of the number of seconds corresponding to one centimetre is accordingly 2.480, and the number itself 302.

APPENDIX C.

AREA OF APERTURES.

THREE apertures were used in Photometers E, G, and I. The first aperture, the area of which may be denoted by A, was formed of two pieces of cardboard, and was employed only on Oct. 1, 1877. The cardboard was replaced by two brass plates, forming an aperture of area B, which were used until Nov. 19, 1877. The aperture of Photometers G and I had an area C, and was formed by two new plates which were used after the date last mentioned. The area corresponding to any screw reading was found as follows, by the help of the Coast Survey Micrometer described on page 42 of Vol. VIII. of these Annals. The pitch of the photometer screw was found with sufficient precision from the scale by which the number of turns was counted. The number of revolutions of the micrometer screw answering to fifty divisions of this scale was found in three successive settings to be 24.297, 24.298, and 24.294. Accordingly, since the pitch of the Coast Survey screw is $\frac{1}{24}$ of an inch, the pitch of the photometer screw is .020247 inches, or .05143 cms. The two plates always move by equal amounts in opposite directions; hence if the aperture always remained a perfect square, its diagonal, according to the result just obtained, should increase .1029 cms. for each turn of the screw. The value of the area A in cms.² for any reading S of the screw would then be given by the formula $A = .00529 (S - S_0)^2$, in which S_0 is the reading of the screw at the point where the aperture closes. This condition will only be fulfilled when the sides are straight and at right angles, inclined 45° to the axis of the screw, and the two plates exactly opposite each other. If this last condition is not satisfied, the aperture when reduced becomes an elongated rectangle, and finally dis-

TABLE LXVI.

Angle.	Reading 30.044		Reading 24.000		Reading 17.000	
	Upper Screw.	Lower Screw.	Upper Screw.	Lower Screw.	Upper Screw.	Lower Screw.
<i>a</i>	66.90	76.38	63.64	77.91	61.67	80.24
<i>b</i>	66.63	85.99	63.36	83.39	61.63	81.03
<i>c</i>	56.67	85.82	57.72	83.13	60.87	80.94
<i>d</i>	57.60	75.89	58.39	77.51	61.11	80.16

appears as a line instead of a point. The amount of error likely to result from these defects was investigated by measuring two co-ordinates of each corner of the aperture, the photometer screw being set successively at 30.044, 24.000, and 17.000. The readings are given in Table LXVI. The corners are denoted by *a*, *b*, *c*, and *d*, *b* being that next the screw-head, and *d* that opposite it. The upper screw of the Coast Survey Micrometer was placed nearly paral-

lel to *ad*. Each setting was made twice, the average deviation from the mean being about one-thousandth of a centimetre.

These measures give the three areas of the apertures as 94.30, 30.35, and .53. The reading of the photometer screw at which the aperture was wholly closed was found by measures made with an eye-piece micrometer at readings near that which was to be determined, and the adopted value was 15.94. Hence the area may be represented by the expression $.47 (S - 15.94)^2$, the unit of linear measurement being the pitch of the micrometer screw, or $\frac{1}{24}$ of an inch. For the values of *S*, 30.044, 24.000, and 17.000, the results given by this formula are 93.44, 30.53, and .53. The slight divergence from the observed values is probably partly due to irregularities in the cardboard, and the impossibility of cutting it so as to leave a sharp corner. The difference is, however, far less than the errors of a photometric comparison, and may therefore be neglected.

The reduction of the coefficient to .47 from its theoretical value .50 shows that the aperture was not a perfect square, especially when considerably reduced.

The area of the aperture in cms.², corresponding to the area just obtained, is $.47 \times (.106)^2 \times (S - 15.94)^2$, or .00528 $(S - 15.94)^2$, in which the value of the coefficient closely agrees with that previously found for it from the pitch of the photometer screw.

The aperture formed by the brass plates substituted, as has been said, for the pieces of cardboard, was measured in a manner similar to that explained above. The plates were separated so as to form a square hole, half an inch on a side, and laid horizontally on the micrometer, the sides of the square being very nearly parallel to the screws. Measurements were then made of

TABLE LXVII.

Upper Screw.	Lower Screw.	Computed.	Difference.	Lower Screw.	Upper Screw.	Computed.	Difference.
68.350	58.091	58.091	.000	46.091	68.504	68.504	.000
70.350	58.141	58.066	+.075	48.091	68.490	68.484	+.006
72.350	58.088	58.041	+.047	50.091	68.469	68.464	+.005
74.350	58.043	58.016	+.027	52.091	68.456	68.444	+.012
76.350	57.997	57.991	+.006	54.091	68.432	68.424	+.008
78.350	57.935	57.966	-.031	56.091	68.383	68.404	-.021
80.350	57.849	57.941	-.092	58.091	68.346	68.384	-.038
Lower Screw.	Upper Screw.	Computed.	Difference.	Upper Screw.	Lower Screw.	Computed.	Difference.
45.821	69.061	69.056	+.005	68.84	57.821	57.821	.000
47.821	69.022	69.021	+.001	70.84	57.801	57.781	+.020
49.821	68.978	68.986	-.008	72.84	57.734	57.741	-.007
51.821	68.953	68.951	+.002	74.84	57.681	57.701	-.020
53.821	68.896	68.916	-.020	76.84	57.649	57.661	-.012
55.821	68.843	68.881	-.038	78.84	57.622	57.621	+.001
57.821	68.846	68.846	.000	80.84	57.610	57.581	+.029

the co-ordinates of the opposite corners of the square and also of points along each side at regular intervals of two turns of one of the micrometer screws (.2117 cms.). These co-ordinates are given in the first and second columns of Table LXVII.

An examination of the second column shows that the sides of the hole are neither straight nor parallel to the screws. If straight, their first differences should be constant, and if parallel,

there should be no progressive changes from one end to the other of each set. By a graphical construction it was found that the latter deviations could be eliminated by regarding the sides as four lines inclined at angles of $43'.0$, $34'.4$, $60'.2$, and $68'.8$, to the axis of the screws. From these values the numbers in the third column are computed. The fourth column gives the differences between the observed and computed readings. One of the corners not being as sharp as was desired, an attempt was made to improve it with a knife. A notch was thus made about a hundredth of a centimetre in depth. This makes the first reading of the first set too small, and the differences larger. As, however, the greatest deviation is less than a hundredth of a centimetre, they will not sensibly affect the observations. Care was taken that the two plates should be set exactly opposite each other, so that when nearly closed the aperture should be reduced to a point and not to a line. It may therefore be assumed that the aperture is nearly a rhombus, having two opposite angles $88^\circ 42'.6$ and $87^\circ 51'.0$, and the other angles nearly equal. The area B will then be closely represented by the formula $B = .5136 (S - S_0)^2$, in which $(S - S_0)$ represents the number of turns of the screw required to close the opening, and the unit of linear measurement is the pitch of the micrometer screw, or $\frac{1}{24}$ of an inch. Comparing this formula with that given on page 306 for the cardboard aperture, it appears that the corresponding areas for equal diagonals are as .47 is to .514. The value of S_0 is given below in Appendix D.

The aperture of Photometers G and I was much more accurately formed than that of Photometer E. It was measured like that of E by the Coast Survey Micrometer. To test the straightness of the edges, the following measurements were taken. The first column gives the reading of the upper, and the second of the lower screw of the micrometer. Had the edge of the aperture been straight and parallel to the lower screw, all of the readings of the second column should have been the same. The progressive increase shows that the condition of parallelism was not fulfilled. This is accordingly corrected in the third column by assuming that the inclination is about $1^\circ 26'$. The fourth column gives the difference of columns three and two. The unit being $\frac{1}{24}$ of an inch, it follows that the extreme difference never equals $\frac{1}{500}$ of a centimetre, a quantity wholly inappreciable photometrically.

TABLE LXVIII.

Upper Screw.	Lower Screw.	Computed.	Difference.
53.993	105.004	105.000	+.004
54.993	105.015	105.025	-.010
55.993	105.036	105.050	-.014
56.993	105.064	105.075	-.011
57.993	105.089	105.100	-.011
58.993	105.117	105.125	-.008
59.993	105.143	105.150	-.007
60.993	105.172	105.175	-.003
61.993	105.196	105.200	-.004
62.993	105.220	105.225	-.005
63.993	105.243	105.250	-.007
64.993	105.279	105.275	+.004
65.993	105.300	105.300	.000
66.993	105.340	105.325	+.015
67.993	105.348	105.350	-.002

The angles of the two plates were determined by reading the co-ordinates, first of the apex of the V, then of a point on one edge ten or twelve turns distant, then of the apex again, of a point on the other edge, and lastly of the apex. In Table LXIX. these readings are given for both the upper and lower plates.

TABLE LXIX.

Upper Plate.		Lower Plate.	
Upper Screw.	Lower Screw.	Upper Screw.	Lower Screw.
53.994	105.008	93.262	62.541
65.994	105.352	93.323	52.541
53.997	105.013	93.261	62.535
54.314	93.013	103.261	62.649
53.993	105.017	93.267	62.551

From this it appears that the edges of the upper plate were inclined $+1^{\circ} 37'$ and $-1^{\circ} 31'$ to the upper and lower screws respectively, or that the angle between them equals $90^{\circ} 6'$. Similarly, in the lower plate, the inclination was $-21'$ and $+37'$, and its angle $90^{\circ} 16'$.

To determine the relative position of the two plates or the remaining two angles of the aperture was a matter of greater difficulty, since one sliding over the other, both could not be brought to focus at the same time. The co-ordinates of the four corners were observed in turn, the first being repeated. They are given in Table LXX.

TABLE LXX.

Lower Screw.	Upper Screw.
93.374	63.361
93.434	52.582
104.553	52.347
104.803	63.516
93.381	63.408

From this it appears that the four edges were inclined $-18'$, $-1^{\circ} 13'$, $+1^{\circ} 17'$, $+40'$ to the screws, or that the angles of the aperture were $90^{\circ} 22'$, $91^{\circ} 31'$, $90^{\circ} 4'$, $88^{\circ} 3'$. The close agreement of the third and first of these angles with the corresponding values obtained above, serves as a check on the accuracy of this result. The small differences of $2'$ and $6'$ are easily accounted for by the difficulty of setting on the edges of plates of brass, especially where, as in the present case, the objects did not lie in the same plane, and their images were out of focus. The area of this trapezium is 123.94, and its shorter diagonal, or that parallel to its screw, is 15.707. The square of the latter equals 246.71, hence the area C for any screw reading S is given by the formula $C = .502 S^2$. When the aperture was closed, the two corners of the brass plates came together, as in the second form of Photometer E, so that no correction is necessary on this account. Since the pitch of the screw is one-eighth of an inch, or .3175 cms., the value of C in cms.² will be .0506 S². S₀ in this case equals zero, since the plates are so set that the aperture is closed when the reading of the screw is zero.

APPENDIX D.

ZERO OF PHOTOMETER E.

THE zero-point of the screw or S_0 was found by viewing the plates through a magnifying glass when turned towards a strong light. The results are given in Table LXXI., in which the consecutive columns give a number for reference, the number in Table I., the number of settings, the mean reading, and the initial of the observer.

TABLE LXXI.

No.	No. in Table I.	Date. 1877.	No. of Settings.	Reading.	Obs.
1	321	Oct. 3	5	14.735	P.
2	322	" "	1	14.734	P.
3	354	Oct. 8	5	14.729	P.
4	472	Oct. 23	5	14.767	P.
5	495	Oct. 24	5	14.743	P.
6	523	Nov. 1	5	14.739	P.
7	608	Nov. 14	5	14.745	P.
8	691	Nov. 21	5	14.664	P.
9	692	Nov. 22	5	14.671	P.
10	693	" "	5	14.666	P.
11	694	" "	5	14.726	P.

After taking the first set, the aperture was opened to its full extent before making the single reading of set No. 2, which showed that this extensive movement of the screw had not affected the zero. The large value of set No. 4 is due to the faint light used, which rendered the aperture invisible when very small. The constancy of the readings from October 3 to November 14 rendered it a matter of surprise on November 21 that the zero resulting from set No. 7 should differ by eight divisions from those previously determined. A simple explanation was found in the fact that the micrometer was taken to pieces on the afternoon of November 15, and the pin holding the end of the screw turned over. Replacing it brought the zero back in set 11 to its original value. The mean of the sets numbered 1, 3, 4, 5, 6, 7, and 11, is 14.741, while the mean of Nos. 8, 9, and 10 is 14.667. Accordingly, 14.74 is taken as the zero for all readings preceding November 16, and 14.67 for the later readings. The formulas for the areas therefore become $B = .514 (S - 14.74)^2$, and $B = .514 (S - 14.67)^2$. If we adopt the centimetre as the unit of length, these values of B respectively become $.577 (S - 14.74)^2$, and $.577 (S - 14.67)^2$.

APPENDIX E.

FOCAL LENGTHS OF AUXILIARY TELESCOPES.

THE focal lengths of the objectives of the auxiliary telescopes of Photometers D and E were determined by Bessel's method as follows. A steel scale a metre in length, and divided into millimetres, was set on its edge in a wooden stand. Four sliders could be moved over it and fastened in any position with set screws. Their distances from the end were marked by indices. To one of these sliders the objective was attached, to the second an eye-piece, and to the others two pointed brass bars, the centres of all being at the same height above the scale. They may be distinguished as *A*, *B*, *C*, and *D* respectively. *C* was set at 30.50 cms., and *B* was focused upon it. *C* was then moved to 60.00 cms., so that the distance of its point from the focal plane of *B* was exactly 29.50 cms. *A*, to which was attached the objective of Photometer D, was then inserted between *B* and *C*, and moved until a distinct image of the point of *C* was seen in the eye-piece of *B*. There are two positions in which this is the case, equidistant from the point midway between the point of *C* and its image formed by the lens. Each of these settings was repeated three times, and the mean gave the values 25.51 and 30.65. Their difference, or 5.14, equals the difference of the conjugate foci of the lens. If the thickness of the lens could be neglected, 29.50 would equal the sum of the foci. But as the light has to pass through a piece of glass whose index of refraction n is about 1.5, the virtual length of this portion will be less than its real length in the ratio of n to 1, or by about one-third. The thickness of the lens was found by placing the brass point of *D* opposite that attached to *C*, reading the index of *C* when the points were in contact, and again when the lens was inserted between them. Three readings gave the thickness of the centre of the lens as 1.41 cms. Calling u and v the conjugate foci, we shall have $u + v = 29.50 - .47 = 29.03$, and $u - v = 5.14$. From the formula $\frac{1}{F} = \frac{1}{u} + \frac{1}{v}$, we obtain $F = 7.030$ cms. The measurement was repeated, changing the total distance through which *C* was moved to 31.00 cms.; $u + v$ therefore equalled 30.53. Three measures gave $u - v = 8.49$, and consequently $F = 7.042$. The mean of these values, or 7.036 cms., may be taken as the true focal length of the lens.

A similar measurement of the objective of Photometer E gave the following result. Uncorrected length of $u + v$, 96.74 cms.; thickness of lens, .77; corrected value of $u + v = 96.74 - .26 = 96.48$; observed value of $u - v = 14.60$. Hence $F = 23.57$ cms. A second measure gave $u + v = 94.99 - .26 = 94.73$; $u - v = 5.17$, and $F = 23.61$. The mean value, $F = 23.59$, is adopted in the reductions.

APPENDIX F.

SATELLITES OF MARS IN 1879.

ANOTHER series of measurements of the light of the outer satellites of Mars was undertaken in 1879. Observations were obtained with Photometers I and J on three nights when the satellite preceded, and on three when it followed the planet. The results are given in Table LXXII., in which the columns have the same meaning as in Tables LIII. and LIV., except that the second and fifth columns are omitted, and an additional column is inserted before the last column. This contains the residual of each set from the mean of all the measures in that half of the orbit in which the satellite happens to be. In the last column S. denotes Mr. Searle, W., Mr. Wendell, Wo., Mr. Frank Waldo; my own observations are denoted by P.

TABLE LXXII.

OBSERVATIONS OF DEIMOS WITH PHOTOMETERS I AND J.

No.	Date.	Hour.	Standard of Comparison.	Longi- tude.	Single Readings.					Mean Read- ing.	Diff. in Magn. of Images.	Corr. Diff. in Magn.	Resid. one Setting.	Resid. one Set.		Obs.
					1.	2.	3.	4.	5.					I.	II.	
PHOTOMETER I. (1879.)																
1	Oct. 20	11.0	Mars	240	.21	.19	.22	.20	.18	.20	6.50	14.60	.13	+.23	-.02	P.
2	" "	11.8	"	250	.24	.24	.25	.30	.25	.26	7.08	14.02	.17	-.35	-.60	Wo.
3	Nov. 1	11.7	"	80	.21	.24	.23	.26	.25	.24	6.90	14.20	.13	-.17	+.03	P.
4	" "	12.1	"	90	.22	.19	.18	.20	.21	.20	6.50	14.60	.13	+.23	+.43	W.
5	" "	12.6	"	90	.32	.28	.25	.23	.24	.26	7.08	14.02	.23	-.35	-.15	P.
6	" "	12.8	"	90	.19	.21	.25	.20	.18	.21	6.61	14.49	.21	+.12	+.32	W.
7	Nov. 5	8.5	"	100	.25	.27	.21	.20	.19	.22	6.71	14.39	.28	+.02	+.22	P.
8	" "	8.8	"	110	.26	.28	.28	.28	.27	.27	7.16	13.94	.06	-.43	-.23	P.
9	" "	8.9	"	110	.27	.24	.22	.20	.24	.23	6.81	14.29	.19	-.08	+.12	W.
10	Nov. 10	8.4	"	90	.29	.30	.33	.36	.29	.31	7.46	13.64	.17	-.73	-.53	P.
11	" "	8.5	"	90	.29	.28	.28	.22	.24	.26	7.08	14.02	.22	-.35	-.15	W.
12	" "	8.6	"	90	.24	.25	.26	.24	.25	.25	6.99	14.11	.05	-.26	-.06	P.
13	Nov. 23	16.2	"	290	.21	.18	.15	.19	.18	.18	6.28	14.82	.17	+.45	+.20	P.
14	" "	16.4	"	300	.17	.19	.18	.17	.17	.18	6.28	14.82	.10	+.45	+.20	W.
15	" "	16.5	"	300	.24	.23	.20	.20	.19	.21	6.61	14.49	.19	+.12	-.13	P.
16	Dec. 1	6.6	"	310	.18	.19	.19	.20	.17	.19	6.39	14.71	.09	+.34	+.09	P.
17	" "	6.9	"	310	.20	.16	.20	.18	.19	.19	6.39	14.71	.14	+.34	+.09	P.
18	" "	7.6	"	320	.16	.20	.19	.17	.16	.18	6.28	14.82	.19	+.45	+.20	W.
												14.37	.16	±.30	±.21	

No.	Date.	Hour.	Standard of Comparison.	Longi- tude.	Single Readings.					Mean Read- ing.	Diff. in Magn. of Images.	Corr. Diff. in Magn.	Resid. one Setting.	Resid. one Set.		Obs.	
					1.	2.	3.	4.	5.					I.	II.		
PHOTOMETER J. (1879.)																	
1	Nov. 1	12.5	Mars	90	.89	.86	.85	.88	.90	.88	9.72	14.28	.04	-.04	+.13	P.	
2	Nov. 10	8.7	"	90	1.22	.82	.92	.78	.78	.90	9.77	14.23	.32	-.09	+.08	P.	
3	" "	8.9	"	90	.84	.88	.88	.88	1.11	.92	9.82	14.18	.18	-.14	+.03	W.	
4	" "	9.0	"	100	.99	.85	.95	.98	.78	.91	9.80	14.20	.18	-.12	+.05	P.	
5	" "	9.1	"	100	1.03	.92	.78	1.07	1.05	.97	9.93	14.07	.21	-.25	-.08	S.	
6	Nov. 23	15.5	"	290	.78	.87	.77	.92	.80	.83	9.60	14.40	.14	+.08	-.12	P.	
7	" "	15.8	"	290	.77	.64	.80	.82	.75	.76	9.40	14.60	.14	+.28	+.08	W.	
8	" "	15.9	"	290	.86	.73	.70	.74	.88	.78	9.46	14.54	.19	+.22	+.02	P.	
9	Dec. 1	6.0	"	300	.74	.69	.78	.94	.79	.79	9.49	14.51	.17	+.19	-.01	W.	
10	" "	6.2	"	300	.96	1.02	.87	1.02	.92	.96	9.91	14.09	.11	-.23	-.43	P.	
11	Dec. 4	8.7	"	110	.94	1.04	1.00	.96	1.01	.99	9.98	14.02	.07	-.30	-.13	P.	
12	" "	8.9	"	110	1.03	.89	.96	1.04	.89	.96	9.91	14.09	.13	-.23	-.06	W.	
13	" "	9.0	"	110	.92	.91	.89	1.00	1.01	.95	9.89	14.11	.11	-.21	-.04	P.	
14	" "	9.1	"	110	.88	.89	.97	1.02	.92	.94	9.87	14.13	.11	-.19	-.02	W.	
15	Dec. 7	10.3	"	260	.75	.80	.73	.67	.78	.75	9.38	14.62	.10	+.30	+.10	P.	
16	" "	10.7	"	270	.66	.61	.64	.65	.54	.62	8.96	15.04	.13	+.72	+.52	W.	
17	" "	10.8	"	270	.98	.82	.83	.73	.77	.83	9.60	14.40	.17	+.08	-.12	P.	
													14.32	.15	±.22	±.12	

To avoid the source of error noted on page 221, due to the varying position of the prism, the latter was placed to the left in all the observations with Photometer I. When the satellite was to the left of the planet, a diaphragm was inserted in the field having a circular hole in it about .28 cms. in diameter. The satellite was seen near the centre of this hole, and the planet concealed behind its edge. The images of Mars, formed by internal reflection in the glass plate of Photometer J, were on the right of the principal image when the prism was on the left. In order to remove them from the image of the satellite, the auxiliary telescope was placed above on December 7. On all the other evenings it was placed to the left. The principal image of Mars was concealed behind a small piece of tin-foil at the end of a narrow strip of glass projecting from one side of the eye-piece. This strip of glass could accordingly be placed so that it would not be near the image of Deimos.

Two conclusions may be drawn from this Table which require consideration. First, the mean brightness of the satellite is much greater than in 1877, and secondly, its light on the following side exceeds by nearly half a magnitude that on the preceding side. The observations with the two photometers are quite independent of each other, and the close agreement of the results obtained affords an additional check of the correctness of the adopted constants. The measurements are also wholly independent of those made in 1877, different methods and different instruments being employed. The observations with Photometer D were not repeated in 1879, because that instrument had been taken to pieces, and its form was such that it was impossible to reconstruct it with precisely the same constant. No attempt was made to repeat the measures with the minute holes, since the observations made in this way in 1877 were unsatisfactory, owing to the faintness of the satellite. The increased distance of Mars in 1879 rendered it probable, therefore, that it would be useless to repeat the attempt. For the same reason, no measures were made of Phobos, as it was expected that this satellite would be seen in 1879 only with the greatest difficulty. It accordingly seemed best to confine the photometric

work to the observation of Deimos with Photometers I and J, and devote the remaining time to measures of the position of the satellites.

With one exception, all the measurements of 1879 make the satellite brighter than it appears to be by the mean value derived from the observations of 1877, so that it is quite impossible that the difference may be due to errors of observation. Two explanations remain, — the difference of the instruments employed, or a real alteration in the satellite. Although the latter hypothesis appears at first sight improbable, it is strongly supported by observations of the visibility of the satellites in the two years. Table LXXIII. serves to determine the relative brightness of Mars when near its oppositions in 1877, 1879, and 1881–82. The first column gives a current number, the second the date in Greenwich mean time, and the third the excess in magnitudes of the light of Mars over that which it would have at distance unity from the Sun and Earth, applying no correction for defective illumination.

The fourth column gives the angle v , the supplement of which is that between the Sun and Earth as seen from Mars. The fifth and sixth columns contain two corresponding corrections for phase obtained by different methods. The first of these assumes that the reduction in light is proportional to the reduction in area of the disk or that it bears to the maximum value the ratio $\frac{1}{2}(1 - \cos v)$; the alternative correction is computed by Lambert's formula, in which the corresponding ratio of light is $\frac{1}{\pi}(\sin v - v \cos v)$.

As in other portions of this volume, the first of these corrections will be used. It is the simplest, and is pretty certainly not excessive. Indeed, the observations of Zöllner indicate a still greater correction than that given by Lambert's formula. The last column gives the total correction for distance and phase, and is found by subtracting the numbers in column five from those in column three. This gives the assumed correction for the reduction of an observed magnitude of Mars or of the satellite to that which it should have at a distance unity from both the Sun and the Earth.

TABLE LXXIII.
VARIATION IN LIGHT OF MARS.

No.	Date. G.M.T., 0h.	Corr. for Distance.	v.	Corr. for Phase.		Total Corr. Syst. 1.	No.	Date. G.M.T., 0h.	Corr. for Distance.	v.	Corr. for Phase.		Total Corr. Syst. 1.
				System 1.	System 2.						System 1.	System 2.	
1877.													
1	Aug. 11	+ 1.23	157.8	.04	.08	+ 1.19	16	Oct. 31	+ .75	168.5	.01	.02	+ .74
2	" 21	+ 1.36	164.6	.02	.04	+ 1.34	17	Nov. 10	+ .73	174.9	.00	.00	+ .73
3	" 31	+ 1.42	172.7	.00	.01	+ 1.42	18	" 20	+ .62	172.7	.00	.01	+ .62
4	Sept. 10	+ 1.39	173.7	.00	.01	+ 1.39	19	" 30	+ .44	165.0	.02	.04	+ .42
5	" 20	+ 1.28	166.9	.01	.03	+ 1.27	20	Dec. 10	+ .22	158.4	.04	.07	+ .18
6	" 30	+ 1.11	160.2	.03	.06	+ 1.08	21	" 20	− .03	152.7	.06	.11	− .09
7	Oct. 10	+ .89	153.5	.06	.11	+ .83	22	" 30	− .29	148.8	.08	.15	− .37
8	" 20	+ .65	148.6	.08	.15	+ .57	1881–82.						
9	" 30	+ .40	145.1	.10	.18	+ .30	23	Nov. 21	− .13	152.6	.06	.12	− .19
10	Nov. 9	+ .15	142.3	.12	.22	+ .03	24	Dec. 1	− .01	158.8	.04	.07	− .05
11	" 19	− .10	140.3	.13	.24	− .23	25	" 11	+ .08	166.3	.02	.03	+ .06
1879.							26	" 21	+ .10	174.3	.00	.01	+ .10
12	Sept. 21	+ .31	142.5	.12	.21	+ .19	27	" 31	+ .05	175.6	.00	.00	+ .05
13	Oct. 1	+ .46	147.9	.09	.16	+ .37	28	Jan. 10	− .07	168.0	.01	.02	− .08
14	" 11	+ .60	153.1	.06	.11	+ .54	29	" 20	− .25	161.0	.03	.06	− .28
15	" 21	+ .70	160.6	.03	.06	+ .67	30	" 30	− .46	155.3	.05	.09	− .51

In 1877, Deimos was last seen at this Observatory on October 15, and by Mr. Common on October 16. The corresponding increase in magnitudes would therefore be about .70. The observations of Professor Hall ended on October 15, except a single measurement on October 31. On the latter day the correction amounted to .27. In 1879, on the other hand, the maximum brightness only equalled .75, or was but little greater than that on Oct. 16, 1877. If then the satellite underwent no change in its true brightness, all the measurements in 1879 were made on an object so faint that it was observed only with great difficulty in 1877. On Oct. 31, 1877, Professor Hall described Deimos as of about the brightness of Umbriel, the faintest of the known satellites, which is not known to have been seen in the Cambridge telescope. The light of Mars should then have the same brightness as on Dec. 7, 1879. On and after this last date, however, Deimos was observed here with comparative ease.

It might be supposed that the greater visibility of the satellites in 1879 was due to their increased altitude. This doubtless helped, but it is insufficient to account for the whole effect. The meridian altitude at Cambridge in 1877 varied from 35° to 40° ; that in 1879 was about 65° . Many of the observations were made more than four hours from the meridian, where the altitude was less than at meridian transit in 1877. On Nov. 16, 1879, the satellite was followed until $17^h 36^m$ Cambridge mean time, or to within 10° of the horizon. Even as late as December 12 it was followed to within 21° of the horizon.

The great difficulty of seeing the satellites arises from the proximity of Mars. This was well shown in 1879 in several ways. The Moon interfered but little with the observations in November. The best series of position angles of Phobos, consisting of 68 settings, was obtained on November 26 with the Moon less than four degrees distant. A certain amount of light in the field does not seem prejudicial. Independent observations appeared to show that the satellites were sometimes better seen when Mars was brought so near the edge of the diaphragm covering it as to illuminate the field by its light. It is possible that as a certain amount of light is required to affect the retina, the light from the field added to that of the satellite may prove sufficient to render the latter visible. The effect is analogous to the increased sensitiveness of a photographic plate after exposure to a feeble source of light.

The conditions of visibility of the satellites resemble in many respects those of the companion of Sirius; both required a telescope of the largest size for their discovery, but once found were easily seen in much smaller instruments. A steadiness of the images is much more important in both cases than extreme clearness of the air. The effect of twilight in removing the glare of the primary increases the visibility of the companion of Sirius, and does not seem to greatly increase the difficulty of seeing the satellites. It is somewhat remarkable that thin cumulus clouds do not prevent the satellites from being seen. Some observations of their position were secured when the clouds over Mars were thick enough to reduce its light in a marked manner. The clouds formed of ice-crystals, to which halos are due, rendered it very difficult to see the satellites.

The observations of Table LXXII. show a decided difference in the light of the satellite on opposite sides of the planet. When the satellite precedes, or when the longitude is in the neighborhood of 270° , the mean of the readings with Photometer I is 14.62; when near 90° , 14.17. Photometer J in like manner gives 14.52 and 14.15. If the residuals are taken from the mean light in each half of the orbit, the average deviation of a set is reduced to .21 and .12, as is shown in the last column but one. An unexpected confirmation of the difference in light in the two sides was found in the micrometric measurements. This is shown in Table LXXIV.,

which gives in successive columns a current number, the date, the number of settings for position angle of Deimos on the following and preceding sides of the planet, the corresponding measures of distance, and the measures of position angle of Phobos.

TABLE LXXIV.
NUMBER OF OBSERVATIONS IN 1879.

No.	Date.	Deimos.				Phobos.	
		Angles.		Distances.		Angles.	
		Foll.	Prec.	Foll.	Prec.	Foll.	Prec.
1	Oct. 20	—	26	—	—	—	—
2	“ 25	—	1	—	—	—	—
3	“ 26	—	—	—	—	4	4
4	“ 29	—	11	—	—	—	—
5	Nov. 1	69	—	—	—	—	—
6	“ 4	—	4	—	—	—	—
7	“ 5	37	—	—	—	—	—
8	“ 10	31	—	—	—	—	25
9	“ 16	129	—	—	—	20	7
10	“ 21	64	6	20	—	49	2
11	“ 22	—	15	—	—	13	—
12	“ 23	—	45	—	—	8	—
13	“ 24	35	—	30	—	38	—
14	“ 25	30	—	20	—	3	26
15	“ 26	—	5	—	—	—	68
16	“ 29	22	—	20	—	—	—
17	“ 30	99	—	69	—	—	—
18	Dec. 1	—	1	—	—	—	5
19	“ 4	57	—	29	—	5	—
20	“ 7	—	43	—	21	7	—
21	“ 9	44	—	40	—	—	—
22	“ 12	—	45	—	—	—	—
23	“ 17	—	5	—	—	—	—
24	“ 18	35	—	—	—	—	—
25	“ 26	—	5	—	—	—	—
26	“ 30	—	2	—	—	—	—
Total		652	214	228	21	147	137

Most of these observations were made by Mr. Wendell and myself. As far as possible, each in turn made five settings, and the work was continued without interruption as long as the satellite remained visible. Each observer thus obtained frequent rests without in any way delaying the progress of the work, which was accordingly carried on continuously from early in the evening until four, five, or even six o'clock in the morning. Precedence was given to the photometric measures, and next to these to the position angles of Phobos. All of the remaining time was devoted to Deimos. The preponderance of measures of Deimos when on the following side of Mars is very marked, and is made more striking by the equality of the corresponding measures of Phobos. From this we should infer that there was no sensible difference in the light of Phobos at its two elongations, but that the observed difference in brightness of Deimos is confirmed. The inequality in the number of measures of Deimos was not noticed until early in December, but it is doubtful if it could have been avoided except by omitting some of the

other measures. It will be seen also that it was not due to cloudy weather, since Deimos was seen on a nearly equal number of nights on each side.

Although the observations in 1877 did not justify the conclusion that the light of the satellite varied in different parts of its orbit, yet they may be used to increase or diminish the probability of the change inferred from the observations of 1879. A reference to Table XL. shows that the only sets to which much weight can be assigned are those in which the satellite followed the planet. In Table XLI. two-thirds of the observations were on this side of the planet. As appears from page 237, the observations of 1877, like those of 1879, showed a difference in brightness of the satellite in the two halves of its orbit amounting to nearly four-tenths of a magnitude. As there was no means of confirming this difference in 1877, it was then ascribed to errors of observation. Both Tables thus serve to confirm the reality of the variation in light. On the other hand it should be noted that the micrometric observations on the following side of Mars did not preponderate in 1877, but were somewhat less in number than those on the preceding side. The first and last observations of Deimos in 1877 were on the following side of the planet.

Professor Hall has kindly furnished a comparison of Deimos with a star having the position in 1880.0 of R.A. = $3^h 22^m 0^s$ Dec. = $+18^\circ 13' 20''$. This star was about $15''$ south of Deimos on the night of Nov. 4, 1879, when the position angle of the satellite was about 240° , and its distance $60''$. The approximate angle and distance of the star would be accordingly 230° and $70''$. Professor Hall estimated the star as half a magnitude fainter than Deimos. Measurements of this star are given in Table LXXV., the consecutive columns giving a current number, the date, the mean reading, the observed difference in magnitude, and the correction for the loss of light of Mars since November 4. This quantity may be obtained from Table LXXIII. The next column gives the sum of the last two, or equals the difference between the star and Mars when reduced to the brightness it must have had on November 4. The last two columns give the residual from the mean value 14.31, and the initial of the observer.

TABLE LXXV.

STAR OBSERVED BY PROFESSOR HALL.

No.	Date. 1879.	Hour.	Read- ing.	Diff. in Magn.	Red. to Nov. 4.	Corr. Diff. in Magn.	Resid.	Obs.
1	Dec. 1	9.5	.25	14.11	.35	14.46	+ .15	W.
2	" "	9.6	.24	14.20	.35	14.55	+ .24	P.
3	" "	9.7	.24	14.20	.35	14.55	+ .24	S.
4	Dec. 7	6.6	.46	12.79	.50	13.29	- 1.02	S.
5	" "	6.7	.31	13.64	.50	14.14	- .17	P.
6	" "	6.8	.27	13.94	.50	14.44	+ .13	P.
7	" "	7.0	.40	13.09	.50	13.59	- .72	S.
8	Dec. 12	8.8	.23	14.29	.63	14.92	+ .61	W.
9	" "	8.9	.26	14.02	.63	14.65	+ .34	P.
10	" "	9.0	.30	13.71	.63	14.34	+ .03	P.
11	" "	9.0	.28	13.86	.63	14.49	+ .18	W.
				13.80		14.31	$\pm .35$	

This comparison would assign to the satellite a much greater brightness than that obtained by direct measurement. To compare with the mean brightness of the satellite we must apply three corrections to the mean result of Table LXXV. The number 14.31 must be reduced; first, by half a magnitude, the estimated excess of the light of satellite above that of the star; secondly, by about two-tenths of a magnitude, because the satellite was on the preceding side of its orbit; thirdly, because the star was somewhat farther from the planet than the satellite. The satellite, therefore, according to this measurement, would appear much brighter than that given by either of the other measurements. On the other hand, the comparison with stars in 1877, discussed on page 235, appears to make the satellite too faint.

A summary of the various values of the light of Deimos, and of the equivalent diameters to be derived from them, are given in Table LXXVI. The columns have the same meaning as in Table LV. As in the case of Iapetus, equivalent diameters are given corresponding to the maximum and minimum light, since they are intended as measures of brightness and not of distances. The adopted values are derived from the mean of the measurements of Photometers I and J.

TABLE LXXVI.

DIMENSIONS OF DEIMOS DERIVED FROM PHOTOMETRIC OBSERVATIONS.

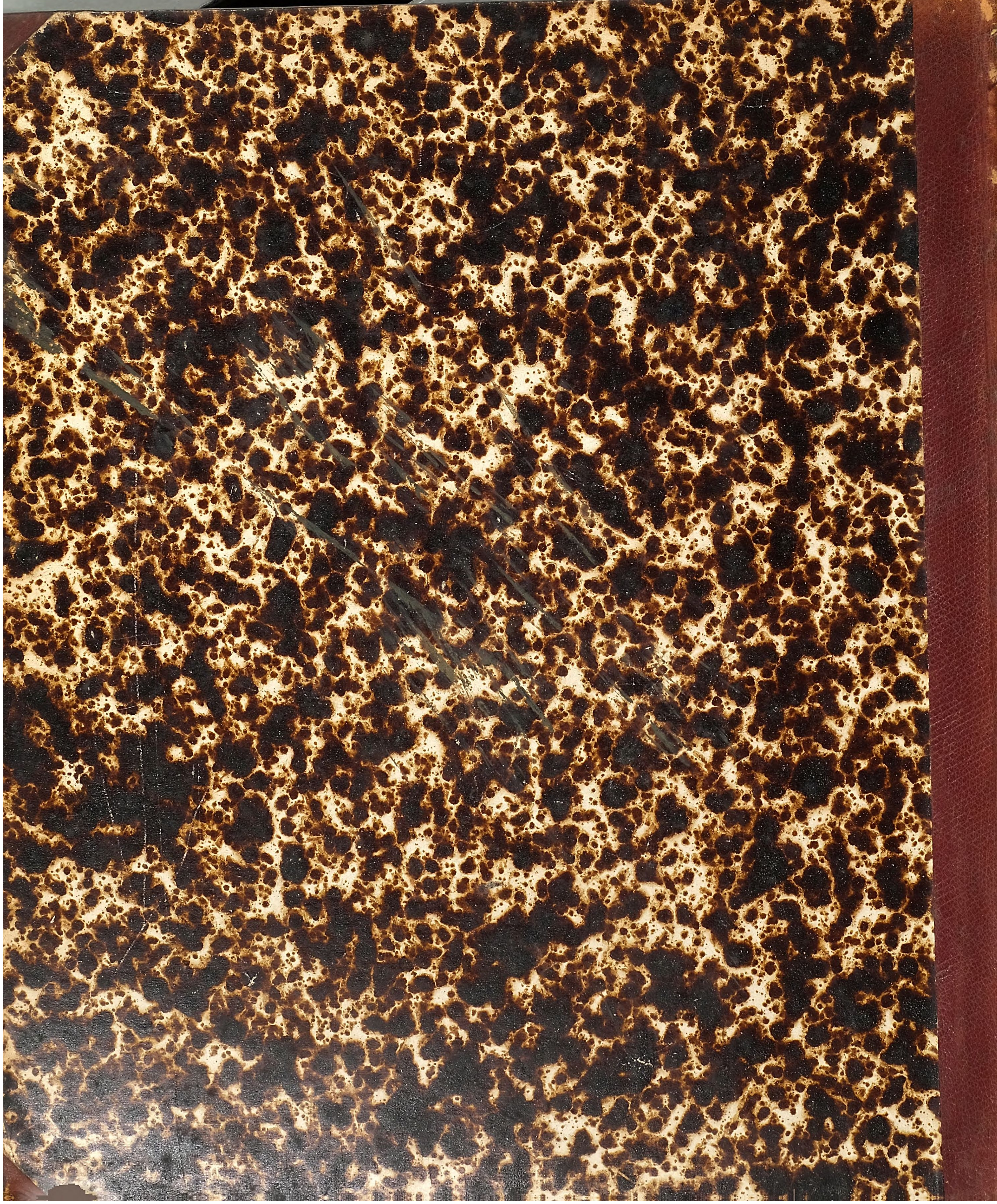
No.	Group.	No. of Sets.	Diff. in Magn.	Log.	Ratio.	Av. Dev.	Prob. Err.	Equivalent Diameter.				
								In Diam. of Mars.	Angle at Mean Distance.	Areocent. Angle.	In Kilometres.	In Miles.
1	Mean, 1877	30	14.86	4.056	879000	.28	.04	.00107 ± .00002	.0071 ± .0001	69 ± 1	7.8 ± 0.1	4.9 ± 0.1
2	Mean, 1879	35	14.35	4.260	550000	.22	.03	.00135 ± .00002	.0089 ± .0001	87 ± 1	9.9 ± 0.1	6.1 ± 0.1
3	Foll. Mars		14.16	4.336	461000			.00147	.0097	95	10.8	6.7
4	Prec. Mars		14.57	4.172	673000			.00122	.0081	78	8.9	5.5

Although no photometric measurements were made of Phobos in 1879, yet it is probable that the same cause which increased the apparent brightness of Deimos affected it also. Phobos was undoubtedly brighter than Deimos, since the latter always disappeared when approaching the planet on reaching a distance much greater than that at which Phobos could be seen. There seems to be no reason for changing the difference in brightness of 0.3 of a magnitude deduced from the observations in 1877. The equivalent diameters of the two satellites would accordingly equal about 10 and 12 kilometres (6 and 7 miles).

ERRATA.

THE preparation of Part II. of this Volume has furnished an independent check of a considerable portion of Table I. Several slight errors have thus been detected, which are given below:—

- Page 19, Nos. 341–344, insert in column of Remarks, “Aperture 12.7 cms.”
- “ 21, “ 474–480, insert in column of Remarks, “Aperture 12.7 cms.”
- “ 22, “ 481–486, insert in column of Remarks, “Aperture 12.7 cms.”
- “ 39, “ 1539, 1540, for H, read [H].
- “ 48, “ 2087, for A, BC, read C.
- “ 79, “ 3936, 3937, for C, read CD.
- “ 81, “ 4040, 4041, for C, read CD.
- “ 85, “ 4285, for 1, read I.
- “ 95, “ 4884, 4885, insert in column of Remarks, “Prism to left and below.”
- “ 95, “ 4886, 4887, insert in column of Remarks, “Prism to left, α out of field.”



Pickering, Edward Charles,

Photometric Observations made principally with the Equatorial Telescope of
Fifteen Inches Aperture during the Years 1877 - 79, by Edward C. Pickering,
aided by Arthur Searle and Winslow Upton

Cambridge 1879

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